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THESIS

**A COMPREHENSIVE ANALYSIS OF THE
MAINTENANCE REQUIREMENT SYSTEM**

by

Michael Andrew Palmer

June 1993

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**A COMPREHENSIVE ANALYSIS OF THE
MAINTENANCE REQUIREMENT SYSTEM**

by

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Lieutenant Commander, United States Naval Reserve
B.A., University of Illinois, 1981

**Submitted in partial fulfillment
of the requirements for the degree of**

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ABSTRACT

The Navy's efficiency and effectiveness is dependent on the material readiness of its ships. It is essential that the programming mechanism for surface ship maintenance account for all required repair work and the relative risk associated with resource allocation, especially during this era of reduced defense spending. The Maintenance Requirement System (MRS) is a tool that appears to accomplish this by defining maintenance requirements, projecting those requirements into the future, and assessing the risk of not fully funding maintenance requirements in terms of degraded mission capability. This thesis examines MRS, current and future issues that impact MRS, and the similarities between MRS and performance budgeting.

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TABLE OF CONTENTS

I.	INTRODUCTION	1
A.	STATEMENT OF THE PROBLEM	1
B.	DEVELOPMENT OF THE RESEARCH QUESTIONS	2
C.	METHODOLOGY	2
II.	BACKGROUND ON MAINTENANCE REQUIREMENT SYSTEM	4
A.	BUDGET ENVIRONMENT PRIOR TO MRS	4
B.	MRS MECHANICS BREAKDOWN	7
	1. Phase One: Defining Requirements	8
	2. Phase Two: Projecting Requirements	12
	3. Phase Three: Managing Risk: Sensitivity Analysis	13
C.	REPRESENTATIVE EXAMPLE: SYSTEM DEMONSTRATION TO THE READER	16
	1. Add Alts/Pkged Effects	17
	2. Tailor Shipsheets	18
	3. Assess Funding Cuts	18
	4. Tailored Shipsheet Report	19
	5. System Administration Menu	19
III.	CURRENT ISSUES: CREDIBILITY	32
A.	MRS REPRESENTATIVE AVAILABILITIES AND THE OPNAVNOTE 4700 NOTIONAL MAN-DAYS: CURRENT DIFFERENCES	34
B.	ADVANCE PLANNING AND FARM-IN/FARM-OUT BAM FACTORS	38

1.	MRS and BAM Factors: Current System . . .	39
2.	Problems With Calculating AP and FIFO From Current Data	39
3.	User Group Recommendations	41
C.	IMPLEMENTING CONSISTENCY IN MRS VERSION 2.0 . .	42
IV.	FUTURE ISSUES: PROJECTING PERFORMANCE AND COMPLI- ANCE WITH PUBLIC LAW	45
A.	ELEMENTS OF PERFORMANCE MEASUREMENT SYSTEM: KEY ELEMENTS AND SIMILARITIES TO MRS	45
B.	IMPLEMENTATION OF THE GOVERNMENT PERFORMANCE AND RESULTS ACT	50
C.	MRS FUTURE ISSUES	53
V.	CONCLUSIONS	57
A.	HOW IS MRS USED IN THE NAVY? DOES MRS HAVE A DIRECT IMPACT ON BUDGETING?	57
B.	WHAT ARE THE CURRENT AND FUTURE ISSUES FACING MRS?	58
C.	AREAS FOR FURTHER RESEARCH	59
APPENDIX A	VALID DATA VALUES AND DATA DERIVATION GUIDELINES	60
APPENDIX B	MRS DEVELOPMENT TIMELINE	69
APPENDIX C	MAINTENANCE REQUIREMENTS SYSTEM DATA DEVELOP- MENT SYSTEM (MDDS)	70
APPENDIX D	GLOSSARY	80
LIST OF REFERENCES	87
INITIAL DISTRIBUTION LIST	89

I. INTRODUCTION

A. STATEMENT OF THE PROBLEM

One of the primary concerns for the United States Navy is obtaining the necessary funding for surface ship maintenance. The Maintenance Requirement System is a recent development that supports planning, programming, and budgeting of funds for surface ship maintenance. The U.S. Navy's ability to carry out its assigned missions can be viewed in part as a function of material readiness. Acquiring and expending funds on surface ship maintenance must therefore be effective and efficient. The incremental form of budget preparation and execution is rapidly becoming obsolete. Primacy of finding a solution to the growing federal deficit will cause the defense budget to be displaced, taking a "back seat" to domestic program initiatives designed to rejuvenate the economy. Executive agencies will be aggressively competing for scarce resources. Within the Department of Defense, similar competition between the Navy's primary warfare communities (surface, aviation, and submarine) exists and has provided impetus to improve budgeting for operational readiness.

Recent pieces of legislation passed by Congress attest to the importance of this topic, specifically, The Chief Financial Officers Act of 1990. Although the primary purpose of the legislation is the improvement of financial accounting

systems within the federal government, the Act includes the beginnings of a greater focus on program results. Additionally, The Government Performance and Results Act (S.20) would initiate a new form of accountability within government programs through the use of performance budgeting techniques. Although The Government Performance and Results Act is not the primary area of research, the Maintenance Requirement System (MRS) has several key elements called for in the legislation. These common elements will be addressed later in the thesis.

B. DEVELOPMENT OF THE RESEARCH QUESTIONS

This thesis documents the Maintenance Requirement System. It begins with an examination of the budget environment that existed when MRS was developed. Then it describes the mechanics of MRS. Finally, it explores current and future issues related to MRS. The thesis focuses on the following questions.

1. How is the Maintenance Requirement System used presently in the Navy?
2. Does MRS have a direct impact on budgeting?
3. What are the issues relating to the current and future issues of the Maintenance Requirement System?
4. What areas are recommended for further research?

C. METHODOLOGY

Basic data for this thesis was obtained from existing Navy instructions, notices and policy manuals on budgeting, MRS

User's Group training materials, field interviews, and the general body of academic literature. Research was conducted in four major steps:

1. Interviews with Naval Sea Systems Command (NAVSEA) (SEA-915/935), American Management Systems, Inc. (AMS) executives, Commander Naval Surface Force Pacific (CNSP) (N-4)
2. Examination of each phase involved in MRS mechanics by perusal of official documents, supplemented by interviews
3. Evaluation of the role of MRS in the budgeting process
4. Evaluation of the role of MRS as a performance budget in light of current legislation.

The resulting research provides a comprehensive examination of the Maintenance Requirement System and how it is employed in the surface ship maintenance Program Objective Memorandum (POM) development and budget process.¹ This research also explores MRS's future application in performance budgeting. Recommendations for potential areas of further research may be found in the concluding chapter.

¹POM is specific programming guidance derived from Defense Guidance (DG) handed down from the Secretary of Defense to each of the service secretaries.

II. BACKGROUND ON MAINTENANCE REQUIREMENT SYSTEM

Chapter II provides the background on MRS. Section A discusses the budget environment. Section B describes the three phases of MRS mechanics. Section C illustrates a system demonstration through a representative example.

A. BUDGET ENVIRONMENT PRIOR TO MRS

In the past, surface ship maintenance managers used a derived or notional man-day number multiplied by current man-day cost to develop the POM. In turn, this figure represented the funds necessary to support specific mission areas delineated by the National Maritime Strategy.²

This method of resource allocation was inherently flawed. Funds requested are a function of total man-days and cost for scheduled maintenance work. Therefore, POM numbers produced are static predictions. As alternative funding recommendations are generated as part of the iterative programming and budgeting process, the specific impact of under-funding surface ship maintenance could not be determined using the traditional notional or "fixed" number approach. Since the POM figures are static predictions and the impact of funding cuts indeterminate, justification of funds requested in the

²National Maritime Strategy (NMS) is the Secretary of the Navy's input to the Secretary of Defense's Defense Guidance. The current NMS is titled "From The Sea."

POM has become difficult. This problem is compounded by the need for financial restraint and cutback in The Navy and Department of Defense. [Ref. 1]

The resulting problems meant that, in an increasingly constrained fiscal environment, POM surface ship maintenance representatives did not possess sufficient evidence to show the impact of proposed program or budget increases or cuts. When asked how a ten percent funding cut would affect maintenance accomplishment, Surface Type Commanders, using the traditional notional approach, responded with the only answer available: We will accomplish ten percent less maintenance [Ref. 2].

Due to the program and budget competition from both the submarine and aviation communities in the Navy, and other factors, a disproportionate share of future funding cuts may be allocated to the surface community. This is especially the case when the impact of resource cuts cannot be quantified in specific terms.

For example, if a budget cut were to be administered to the naval maintenance community, an explanation offered might be that it is more important for a ballistic missile submarine or an aircraft carrier to remain operational than a frigate or destroyer. This may no longer be the case with the end of the Cold War, but until now the Soviet Union has shown no significant sign of reducing its military capability. The

Soviet threat was a critical variable in determining the National Maritime Strategy, which in turn effects POM.

By using notional figures it would have been unreasonable for the surface ship maintenance community not to expect funding cuts, primarily due to the inability to justify proposed POMs. If the surface ship community continued to be assessed funding cuts on a yearly basis, a gradual slip in maintenance dollars would result.

To prevent the likely results of dwindling maintenance funds, Naval Sea Systems Command (NAVSEA)³ Code 915 was directed by Admiral Reimann (then OP-03)⁴ to:

Develop a process for surface ship maintenance budget preparation and justification that will identify funding required...and assess the impact of funding below the requested level [Ref. 2].

Include adequate funding in budget request to meet system readiness objectives and identify the readiness impact of failing to provide the requested funding [Ref. 3].

These directives, coupled with lessons learned from past POM and budget battles, challenged the current budget environment, and the idea of the Maintenance Requirement System (MRS) was created.

The early stages of MRS process development came from the Availability Planning Improvement Process (APIP - a process

³NAVSEA is part of the shore based infrastructure responsible for executing the overhaul and maintenance schedule, established by the CNO, at a naval shipyard or a private shipyard under the jurisdiction of The Superintendent of Shipbuilding (SUPSHIP).

⁴After the Department of the Navy reorganization this is now N86.

used extensively in the submarine maintenance community). This process assigned risk to the deferral of work within the maintenance planning process. The original intent of APIP was to help overhaul planners manage risk in regard to mission readiness. This procedure was modified and expanded to address the new directives. The concept of the Maintenance Requirement System was initiated.

B. MRS MECHANICS BREAKDOWN

The Maintenance Requirement System (MRS) is a computer software program designed to run on a personal computer. MRS may be run in a stand-alone or network (multi-user) environment. For the most efficient results, it is recommended that MRS operate on the following hardware/software:

1. A 100% IBM-AT compatible microcomputer with the following minimum configuration:
 - 80386/33 MHZ (recommended)
 - 640K RAM
 - Hard disk or file server with at least 20MB free space.
2. Novell Netware Version 2.1 or higher (LAN environment only)
3. HP LaserJet or Epson compatible printer. [Ref. 4]

MRS is principally made up of three processes. First, regular maintenance actions need to be determined which must be satisfactorily completed while a ship is in overhaul for its safe and reliable operation during the following operating cycle. A fundamental knowledge of this process is necessary

to understand the next two steps because this is the foundation upon which the Maintenance Requirement System is based. Second, required maintenance actions need to be forecast accurately over the POM years to ensure adequate funding is programmed to execute requirements. Third, given that insufficient resources will result in program and budget short falls, the potential impact of these program short falls needs to be identified and articulated with respect to the ability of the surface Navy to carry out its assigned missions. [Ref. 2]

1. Phase One: Defining Requirements

The first step in MRS is to identify all of the maintenance actions required by a given ship in order to achieve operational goals. The total maintenance requirements that are assembled and engineered by Planning & Engineering For Repairs & Alterations (PERA Surface)⁵ and presented to the Type Commander (TYCOM) for authorization and assignment can be loosely defined as fixed and variable inputs. [For an expanded discussion of the planning process please see Ref. 5]

The fixed inputs are comprised of time directed technical requirements (i.e., preventive maintenance actions such as weight test or hull painting), standard shipyard routines (i.e., docking / undocking, waste removal) and ship alterations (SHIPALTS - jobs relating to safety or

⁵Chartered to assist with overhaul and major availability work package development for designated ship types.

environmental protection compliance or design improvements). These inputs are less likely to change and therefore more predictable for planning or programming purposes. [Ref. 2]

The variable inputs consist of maintenance actions based upon the actual condition of the equipment found during an extensive shipboard inspection program conducted during the availability planning process. The scope or amount of work identified through inspection is variable and therefore more difficult to program for over the POM. [Ref. 2]

The fixed and variable inputs are compiled by PERA to make up the Preliminary Ship Alterations and Repair Package (SARP)⁶. PERA then adds the man-day estimates and their respective rates to form the Proposed SARP. [Ref. 2]

Both fixed and variable maintenance actions in the form of the Proposed SARP are presented at the Work Definition Conference (WDC)⁷. During the WDC, the Type Commander screens the entire work package to the appropriate activity level based on capability and capacity: organization (O - ship's force), intermediate (I - ship intermediate maintenance activity (SIMA) or depot (D - shipyard). The Type Commander authorizes or defers specific maintenance actions based on available funding. Upon completion of the WDC, the Proposed

⁶Displays the ship's total work package showing all work that has been identified, screened to the various repair activities and authorized for accomplishment or disapproved.

⁷Held approximately six months in advance of the availability for the purpose of authorizing work to be performed.

SARP becomes the Authorized SARP, which defines the scope of work at the beginning of the availability. [Ref. 2]

The ship enters its availability and that work is then executed. Growth and new work are experienced and captured in the form of the Completion SARP at the end of the availability. The Completion SARP, together with information about the material performance of the equipment during the follow on operating cycle, is analyzed by PERA and NAVSEA engineers. The results of this analysis are fed back into the planning process for similar ship classes through updates in the Class Maintenance Plan(CMP)/Long Range Maintenance Schedule (LRMS-i.e., variable input) and Time-Directed Requirements (i.e., fixed input). The Completion SARP combined with equipment performance data make up the basic building blocks for input into MRS. [Ref. 2]

The actual process doesn't appear to conform to the intentions noted above regarding the use of the Completion SARP. The reason is two fold. Number one, the first version of MRS utilized the only available data in creating representative availabilities: the three most recent Authorized SARPs. Growth and new work were incorporated into the data base using information collected from Emergent Restricted Availabilities / Technical Availabilities (RATAs)⁸. Number

⁸RA-is an availability assigned for the accomplishment of specific items of work by an industrial activity with the ship present. TA-is an availability for the accomplishment of specific items of work by a repair activity, normally with the ship not present, during which time the ship is fully capable

two, and more importantly, the TYCOM has to spend repair fund dollars in order to "buy" a Completion SARP from PERA. When the TYCOM has a compelling need to "turn wrenches" (fix broken equipment), the disparity between the ideal process and reality is understandable. [Ref. 6]

Utilizing this information as the primary input to the MRS system (i.e., all required maintenance actions needed to accomplish mission objectives) achieves the task of "clearly defining the maintenance requirements for surface ships." [Ref. 2]

The first data input into the MRS system comes from the PERA VAX computer in developing a representative availability. The information provided includes fixed and variable SARP inputs, Ship Work List Item Number (SWLIN)⁹, SWLIN man-day estimates, Equipment Identification Code (EIC)¹⁰, job numbers, man-days, material, and frequency. These inputs represent all required maintenance actions needed to accomplish mission objectives. Additionally, follow on

of performing its assigned mission.

⁹Ship's Work Line Item Number, "SWLIN", is a term used to refer to a specific unit of work defined in the SARP. The SWILN is identified by the four digit SWAB Number, and a one digit number that identifies the reporting level breakdown within each SWAB.

****Note "SWAB" stands for Ships work Authorization Boundary. This four digit number identifies specific systems to be worked on in a Depot level environment.**

¹⁰An alpha-numeric code used in the 3-M system to identify system, sub-system, and equipment in which maintenance is performed.

performance and cost data document the maintenance standards and projected cost of maintenance standards required to achieve mission objectives. [Ref. 2]

2. Phase Two: Projecting Requirements

The second step in the MRS process is to project maintenance requirements over the POM years to ensure adequate funding is programmed to meet those requirements. This is accomplished by comparing the phase one inputs (maintenance requirements and respective cost data) to scheduled availabilities and estimated probabilities of failure. The MRS system computes the probability for systems to fail over time using quarterly maintenance (3M - Maintenance and Material Management System)¹¹ and equipment casualty reports (CASREP)¹² data that has been transferred to the MRS data base by tape diskette. The MRS system designates the probability of failure factor as "Pf." This represents the numerical value of the "need for repair" per system and can be used as an estimate of the probability of specific systems to fail in the future. [See Appendix A, for a detailed discussion on the derivation of this value] Estimated repair costs are then multiplied by the probability of failure factor

¹¹System used throughout Navy for controlling repair, preventative maintenance support which assures maximum equipment operational readiness 3M Corp.

¹²An expeditious means of reporting a diminished combat readiness posture. Advises the operational chain of command of personnel, equipment, material condition which limit operational readiness: also alerts logistical commands.

Pf. This then yields an estimate of how often repairs are required and their respective cost. The MRS system then adds ship availability and scheduling data from the Fleet Modernization Program Management Information System (FMPMIS)¹³ via electronic interface or diskette. Once the MRS system compiles the scheduling, repair probabilities, and repair cost data, the system can

1. Estimate the cost of required maintenance
2. Project when maintenance must be accomplished
3. Display how the timing of expenditures on maintenance coincide with POM.

This accomplishes the second phase of the MRS system: forecasting and justifying the maintenance program and requesting that adequate resources be programmed to execute maintenance requirements. [Ref. 2]

3. Phase Three: Managing Risk: Sensitivity Analysis

The third step in the MRS system quantifies the risks to ship operations associated with funding below the level required to accomplish maintenance requirements identified in phase one. The third phase uses information previously compiled in phases one and two and incorporates new data to achieve its goal. System importance, mission elements, mission criticality and maintenance strategy designations are entered into the MRS system. [Ref. 1] This compiled

¹³FMPMIS-Used to schedule and control the installation of alterations (e.g., ship alterations, machine alterations, etc.)

information becomes the severity of failure factor (Sf). The severity factor indicates the impact on mission readiness when specific equipment is out of commission or degraded. [See Appendix A, for a detailed discussion on the derivation of this value] The severity factor and the probability factor are used to compute the impact of reduced funding for surface ship maintenance at the work item level (SWLIN). Specifically, the relative risk (R) of reducing funds for surface ship maintenance is annotated as:

significance of outcome (severity or Sf)
multiplied by
the likelihood of outcome (probability or Pf)
 $R = Sf \times Pf.$

Application of this computational method could be critical given the present constrained funding environment. Chief of Naval Operations staff (OPNAV), TYCOM's, and the FLEET could be better off at managing and predicting the result of reduced maintenance funds if they used the information provided by the MRS system. The MRS system can provide the following risk analysis information within a "shipsheet"¹⁴ for a specific availability:

1. Severity of failure if work not done
2. Probability of failure if work not done

¹⁴A shipsheet is a listing of representative jobs and associated cost and risk data for a given availability.

3. Missions affected if system fails
4. Criticality of affect on mission.

The following information identifies the impact of less than full funding by applying any combination of "cuts" (user specified) to achieve decrement:

1. A = Availability-percentage of one availability
2. C = Class-percentage across an entire class
3. U = Uniform-percentage across all availabilities
4. V = Vertical-defer availability to another fiscal year.

To identify the impact on specific ship availabilities, the MRS computer ranks each representative job by order of risk. Jobs that support high value, critical mission areas are placed at the top of the list. The MRS system places a dashed line, given a specific level of funding, at some point on the list. Those jobs located below the line can not be accomplished due to projected resource constraints. This application of the MRS system shows the impact of funding cuts.

Maintenance actions affected by reduced funding may be examined using MRS. Changes in mission requirements may be instituted as a function of scarce resources or changing threat. This flexibility allows rapid sensitivity analysis to streamline data input to the POM process in surface ship maintenance. The management decision process should recognize the impact of various options. The MRS system supports programming and budgeting decisions for surface ship

maintenance so that they may be made with an understanding of the risks involved in making decisions. The operational and economic efficiency of the decisions within the surface ship maintenance program may be increased as a result of the information provided by the MRS system.

C. REPRESENTATIVE EXAMPLE: SYSTEM DEMONSTRATION TO THE READER

Once the user has successfully initiated MRS, a logo screen will appear. [Ref. 7]

<h1>MRS</h1>		
=====	MAINTENANCE REQUIREMENTS SYSTEM	=====
Version 1.0 designed and developed by American Management Systems, Inc.		
NEXT - <ENTER>		PREVIOUS - <BACKSPACE>
GLOSSARY - <f1>		QUIT - <f10>

A window will then display prompting for the user's name and password.

		
MAINTENANCE REQUIREMENTS SYSTEM		
Please enter your user name: SYSTEM Please enter your password: XXXXXXXX		
NEXT - <ENTER> GLOSSARY - <f1>	PREVIOUS - <BACKSPACE>	QUIT - <f10>

After logging-on, the screen will display the five primary functions of the MRS system [Ref. 7]:

MRS	MRS MAIN MENU	02/28/92
1 - Add Alts/Pkged Effects 2 - Tailor Shipsheets 3 - Assess Funding Cuts 4 - Tailored Shipsheet Report 5 - System Administration Menu		
NEXT - <ENTER> GLOSSARY - <f1>	PREVIOUS - <BACKSPACE>	QUIT - <f10>

1. Add Alts/Pkged Effects

Selecting this option from the main menu allows the user to add modernization jobs and packaged effects to any shipsheets. For example, if the user has a series of repairs to accomplish on a number of ships of a particular class, this feature allows the user to tailor all the shipsheets in one step [Ref. 6]. Additionally, this function allows the user to assign individual alterations and packaged effects to an availability. These alterations and packaged effects are

defined and maintained in the working tables for each ship class. [Ref. 4]

2. Tailor Shipsheets

Choosing this option allows the user to tailor SWLINS and associated risk factors within a specific availability. This function provides a means to make adjustments to the cost and risk factors associated with individual SWLINS for a given availability. Beginning with the "Official" versions generated during the calculate Shipsheet process, the user may save multiple versions of an availability to facilitate sensitivity analysis and risk assessment. [Ref. 4]

3. Assess Funding Cuts

This option allows the user to enter funding cuts across fiscal years. Horizontal cuts may be applied as a percentage uniformly, by ship class, or by shipsheet. Vertical cuts may also be applied by moving an availability to another fiscal year. Any combination of cuts may be entered; however, the following rules of precedence will be applied:

Availability cut--> over class and uniform cuts

Class cut-----> over uniform cuts

Vertical cut---> applied in combination with horizontal cuts
[Ref. 4]

4. Tailored Shipsheet Report

This option allows the user to print the complete tailored shipsheet in one of the following six sort options:

1. Risk (descending order)
2. SWLIN (ascending order)
3. Prob of fail (descending order)
4. Severity (descending order)
5. MCC (mission criticality code (descending order))
6. Cost (descending order). [Ref. 4]

5. System Administration Menu

This option allows the user to access options to maintain the reference/working tables used to generate and validate shipsheets. However, access is dependent on the access level defined for each user. If the user does not have access to a given function, the menu option will not display on the screen. [Ref. 4]

In order to get started, the user selects option 2 on the main menu, Tailor shipsheets. What the user will see on the screen is a list of all the availabilities in the POM. [Ref. 7]

MRS	Availability List	05/11/1992
Select the Availability to Tailor		
Hull AD 37 AD 38 AD 42 AD 43 AE 28 AE 29 AE 29 AFDL 6 AD 178 AD 179 AD 186	Description SAMUEL GOMPERS, FY 1998, PMA - OFFICIAL PUGET SOUND, FY 1998, DPMA - OFFICIAL ACADIA, FY 1997, PMA - OFFICIAL CAPE COD, FY 1996, PMA - OFFICIAL SANTA BARBARA, FY 1997, DPMA - OFFICIAL MOUNT HOOD, FY 1994, PMA - OFFICIAL MOUNT HOOD, FY 1997, PMA - OFFICIAL DYNAMIC, FY 1997, SCO - OFFICIAL MONONGAHELA, FY 1995, PMA - OFFICIAL MERRIMACK, FY 1997, PMA - OFFICIAL PLATTE, FY 1995, PMA - OFFICIAL	Start Date 12/15/1997 10/20/1997 11/04/1996 10/02/1995 10/16/1996 10/04/1993 10/07/1996 11/06/1996 12/04/1994 11/25/1996 12/12/1994
SELECTION LIST		
NEXT - <ENTER> PREVIOUS - <BACKSPACE>		
GLOSSARY - <f1>		QUIT - <f10>
< Screen 1 of 2 >		

From left to right the user will see

- Hull Type (e.g., FFG 8)
- Description (e.g., McInerney, FY 1997, DSRA - OFFICIAL)
- Start Date (e.g., 10/17/96).

The user can choose to sort the jobs in the availability in any one of the six methods mentioned below.

MRS	Tailor Shipsheet	02/28/92
Select the Sort Order for the Shipsheet Jobs		
1 - RISK (descending order) 2 - SWLIN (ascending order) 3 - PROB OF FAIL (descending order) 4 - SEVERITY (descending order) 5 - MCC (descending order) 6 - COST (descending order)		
NEXT - <ENTER> PREVIOUS - <BACKSPACE>		
GLOSSARY - <f1>		QUIT - <f10>
< Screen 2 of 2 >		

The sort method of greatest interest is the risk ordered method. [Ref. 7]

Once selected, the screen presents a header across the top portion.

NRS		Tailor Shipsheet		05/08/1992			
Availability Title: MCINERNEY, FY 1997, DSRA - OFFICIAL							
Repair Activity: SUPSHIPS JACKSONVILL Ship Name: MCINERNEY							
Ship Class: FFG 7		Hull Number: FFG 8					
Availability Type: DSRA		Man-Day Rate: 420.22					
Sched Begin Date: 10/17/1996		Sched End Date: 01/17/1997					
Total Mandays: 32,582		Total Cost: 19,405,617					
Alt/	MCC-EAL	Mandays	Material	Job Edit	Prob	(000)	
SWLIN				Note?	Sev	Fail	
						Risk	
						Cost	
83711		4	256	D N	0	0	2
98821		2	1,157	D N	0	0	2
83011		6	164	D N	0	0	3
57011		7	109	D N	0	0	3
8441X		8	0	D N	0	0	3
85321		13	880	D N	0	0	6
85311		17	266	D N	0	0	7
85711		10	6,463	D N	0	0	11
EDIT LIST							
NEXT - <ENTER>			PREVIOUS - <BACKSPACE>				
GLOSSARY - <f1>			QUIT - <f10>				
< Screen 2 of 2 >							

The header contains:

- Ship Name (e.g., McInerney)
- Repair Activity (e.g., SUPSHIPS Jacksonville)
- Availability Type (e.g., DSRA see Appendix A for valid values)
- Scheduled Start Date (e.g., 10/17/96)
- Scheduled End Date (e.g., 01/17/97)
- Total Mandays (e.g., 32,582)
- Total Cost (e.g., 19,405,617). [Ref. 7]

The lower portion of the screen presents a list of jobs. From left to right the user is given:

- ALT/SWLIN (this is a numerical break down of all maintenance tasks. A help key (F2) displays the description for the user)
- MCC (mission criticality code identifies the relative importance of the system to the ship's missions, see Appendix A for further discussions)
- EAI (identifies the importance of the maintenance task: E = Essential, A = Advisable, I = Insurance) (See Appendix A for further discussion)
- Mandays (number of mandays for this system maintenance)
- Material (material cost for the maintenance of this item)
- Typ (job type: D --> required overhead job, to allow work package to be performed, risk is not assigned. R --> repair jobs, risk assigned. This field has been modified in MRS Version 1.1. The new field is called job category (See Appendix A for valid values)
- Note? (edit? - can change to "Y" to attach a note to this item. An asterisk indicates a note exists)
- Sev (Severity of failure)
- Fail (Probability of failure)
- Risk (Risk = Sf x Pf)
- Cost (in thousands, the dollar cost of this item).
[Ref. 4]

MRS		Tailor Shipsheet		05/08/1992		
Availability Title: MCINERNEY, FY 1997, DSRA - OFFICIAL						
Repair Activity: SUPSHIPS JACKSONVILL Ship Name: MCINERNEY						
Ship Class: FFG 7 Hull Number: FFG 8						
Availability Type: DSRA Man-Day Rate: 420.22						
Sched Begin Date: 10/17/1996 Sched End Date: 01/17/1997						
Total Mandays: 32,582 Total Cost: 19,405,617						
Alt/	MCC-EAI	Mandays	Material	Job Edit	Prob	(000)
SWLIN				Typ Note?	Sev Fail Risk	Cost
83711		4	256	D N	0 0 0	2
98821		2	1,157	D N	0 0 0	2
83011		6	164	D N	0 0 0	3
57011		7	109	D N	0 0 0	3
8441X		8	0	D N	0 0 0	3
85321		13	880	D N	0 0 0	6
85311		17	266	D N	0 0 0	7
85711		10	6,463	D N	0 0 0	11
EDIT LIST						
NEXT - <ENTER>			PREVIOUS - <BACKSPACE>			
GLOSSARY - <f1>			QUIT - <f10>			
< Screen 2 of 2 >						

The items at the top of the list are job type "D," depot routines, the "price of admission" [Ref. 6].

For example, scrolling down to SWLIN number 99711 the user can see by selecting help (<F2>) that this SWLIN is for docking and undocking the ship. [Refs. 6, 7]

MRS		Tailor Shipsheet		05/11/1992		
Availability Title: MCINERNEY, FY 1997, DSRA - OFFICIAL						
Repair Activity: SUPSHIPS JACKSONVILL Ship Name: MCINERNEY						
Ship Class: FFG 7 Hull Number: FFG 8						
Availability Type: DSRA Man-Day Rate: 420.22						
Sched Begin Date: 10/17/1996 Sched End Date: 01/17/1997						
Total Mandays: 32,582 Total Cost: 19,405,617						
Alt/	MCC-EAI	Mandays	Material	Job Edit	Prob	(000)
SWLIN				Typ Note?	Sev Fail Risk	Cost
99231		228	10,064	D N	0 0 0	106
98011		256	3,843	D N	0 0 0	111
AAAAA		0	132,783	D N	0 0 0	133
98211		304	8,381	D N	0 0 0	136
99311		328	10,068	D N	0 0 0	148
0XXXX		456	7,501	D N	0 0 0	199
98221		496	37,292	D N	0 0 0	246
99711		295	133128	D N	0 0 0	257
DOCK/UNDOCK SHIP EDIT LIST						
NEXT - <ENTER>			PREVIOUS - <BACKSPACE>			
GLOSSARY - <f1>			QUIT - <f10>			

Note that there is not an assigned risk factor.

Scrolling down still further discloses the first repair job, SWLIN number 63421 (flight/hanger deck nonskid). This is the SWLIN with the most risk. [Refs. 6, 7]

MRS		Tailor Shipsheet				05/11/1992			
Availability Title: MCINERNEY, FY 1997, DSRA - OFFICIAL									
Repair Activity: SUPSHIPS JACKSONVILL Ship Name: MCINERNEY									
Ship Class: FFG 7				Hull Number: FFG 8					
Availability Type: DSRA				Man-Day Rate: 420.22					
Sched Begin Date: 10/17/1996				Sched End Date: 01/17/1997					
Total Mandays: 32,582				Total Cost: 19,405,617					
Alt/	SWLIN	MCC-EAI	Mandays	Material	Job	Edit	Prob	(000)	
					Typ	Note?	Sev	Fail	Risk
									Cost
	99311		328	10,068	D	N	0	0	0
	0XXXX		456	7,501	D	N	0	0	0
	98221		496	37,292	D	N	0	0	0
	99711		295	133,128	D	N	0	0	0
	99221		604	50,150	D	N	0	0	0
	99211		1,086	193,930	D	N	0	0	0
	99211		1,724	470,081	D	N	0	0	0
	63421	2 E	69	5744	R	N	100	85	85
EDIT LIST									
NEXT - <ENTER>					PREVIOUS - <BACKSPACE>				
GLOSSARY - <f1>					QUIT - <f10>				
< Screen 2 of 2 >									

Scrolling down the list will reveal that in general the probabilities and severities are decreasing.

Some SWLINs however, such as laundry and dry cleaning spaces, have a low severity and a very high probability.

[Refs. 6, 7]

MRS		Tailor Shipsheet		05/11/1992			
Availability Title: MCINERNEY, FY 1997, DSRA - OFFICIAL							
Repair Activity: SUPSHIPS JACKSONVILL Ship Name: MCINERNEY							
Ship Class: FFG 7 Hull Number: FFG 8							
Availability Type: DSRA Man-Day Rate: 420.22							
Sched Begin Date: 10/17/1996 Sched End Date: 01/17/1997							
Total Mandays: 32,582 Total Cost: 19,405,617							
Alt/	SMLIN	MCC-EAI	Mandays	Material	Job Edit	Prob	(000)
					Typ Note?	Sev Fail Risk	Cost
31311	2	A					13
51711	2	A					83
11021	2	A					660
54211	2	A					12
51311	1	A					63
47511	2	I	103	20,328	R N		26
12011	1	A	161	2,572	R N		26
655XX	1	A	175	27826	R N	40 65	26
LAUNDRY/DRY CLEAN SPACES				EDIT LIST			
NEXT - <ENTER>				PREVIOUS - <BACKSPACE>			
GLOSSARY - <f1>				QUIT - <f10>			
< Screen 2 of 2 >							

Others have high severity and low probability of requiring depot repairs if the work is deferred, such as main lube oil piping. [Refs. 6, 7]

MRS		Tailor Shipsheet		05/11/1992			
Availability Title: MCINERNEY, FY 1997, DSRA - OFFICIAL							
Repair Activity: SUPSHIPS JACKSONVILL Ship Name: MCINERNEY							
Ship Class: FFG 7 Hull Number: FFG 8							
Availability Type: DSRA Man-Day Rate: 420.22							
Sched Begin Date: 10/17/1996 Sched End Date: 01/17/1997							
Total Mandays: 32,582 Total Cost: 19,405,617							
Alt/	SMLIN	MCC-EAI	Mandays	Material	Job Edit	Prob	(000)
					Typ Note?	Sev Fail Risk	Cost
6311X	1	A	569	6,139	R N	30 35 11	245
6311X	2	A	539	59,625	R N	30 35 11	286
643XX	1	I	308	157,361	R N	30 35 11	287
76311	1	A	21	385	R N	100 10 10	9
52211	2	A	18	5,521	R N	100 10 10	13
58321	2	I	15	21,544	R N	100 10 10	28
32111	2	I	45	1,798	R N	85 10 9	21
2621X	2	E	44	9187	R N	88 10 9	28
MAIN LUBE OIL PIPING				EDIT LIST			
				PREVIOUS - <BACKSPACE>			
				QUIT - <f10>			
< Screen 2 of 2 >							

The bottom of the list are items with the lowest risk assigned, for example stowage lockers. [Refs. 6, 7]

MRS		Tailor Shipsheet		05/11/1992		
Availability Title: MCINERNEY, FY 1997, DSRA - OFFICIAL						
Repair Activity: SUPSHIPS JACKSONVILL		Ship Name: MCINERNEY				
Ship Class: FFG 7		Hull Number: FFG 8				
Availability Type: DSRA		Man-Day Rate: 420.22				
Sched Begin Date: 10/17/1996		Sched End Date: 01/17/1997				
Total Mandays: 32,582		Total Cost: 19,405,617				
Alt/	MCC-EA1	Mandays	Material	Job Edit	Prob	(000)
SWLIN				Typ Note?	Sev Fail	Risk Cost
665XX	1 I	201	26,091	R N	66 10	7 111
2513X	2 I	166	15,971	R N	60 10	6 86
52911	1 A	16	94	R N	40 10	4 7
2642X	1 I	27	325	R N	40 10	4 12
52611	1 I	68	1,503	R N	40 10	4 30
52811	1 I	128	16,996	R N	40 10	4 71
1232X	1 I	236	5,759	R N	40 10	4 105
671XX	1 I	19	3180	R N	30 10	3 11
LOCKERS & SPECIAL STORAGE			EDIT LIST			
- <BACKSPACE>						
QUIT - <f10>						
< Screen 2 of 2 >						

This would be one of the first jobs deferred in the event of a budget reduction.

At this point, the user has completed reviewing and updating various SWLINS. If the user were informed of a pending budget drill, he would return to the main menu and select option 3: Assessing funding cuts.

The user identifies the title of the set of cuts to be evaluated (e.g., TEST) and then enters one of four scope choices:

MRS		Assess Budget Cuts		05/11/1992	
Enter Budget Cuts Title					
<div style="border: 1px solid black; padding: 10px; margin: 10px auto; width: 80%;"> Cuts Title: TEST </div>					
Identify the title of the set of cuts to be evaluated					
NEXT - <ENTER>			PREVIOUS - <BACKSPACE>		
GLOSSARY - <f1>			QUIT - <f10>		
< Screen 1 of 4 >					

- C Across a class
- A A specific availability
- U Uniformly across all availabilities
- V Move availability to next fiscal year.

For purposes of illustration, he selects "U". Next the user specifies the years affected (e.g., 94-99) and the percent to be cut (e.g., 10).

The dollars (in thousands) affected and cut are shown in the "Pre-cut" and "cut" columns. The total effect on each fiscal year is shown (in millions of dollars) in the "Pre-cut" and "Post-cut" totals across the top of the screen. [Ref. 7]

MRS		Assess Funding Cuts					05/11/1992		
		1994	1995	1996	1997	1998	1999		
Pre-Cut Totals (M\$)		331	275	195	498	382	439		
Post-Cut Totals (M\$)		298	248	176	448	344	395		
Dollars Cut (M\$)		33	28	20	50	38	44		
Cut	Class/	Sched	New	Applied	Pct	Pre-Cut	Cut		
Scope-Hull Num	Start	Start	Cut FYs	Cut	\$ (000)	\$ (000)			
U	/ /	/ /	94- 99	10	2120913	212091			

NEXT - <ENTER>		PREVIOUS - <BACKSPACE>	
GLOSSARY - <f1>		QUIT - <f10>	

Six reports show the effect of the cut:

- Consolidated results (by: availability type)
- Consolidated results (by: program element)
- Consolidated results (by: pre/post cuts)
- Mission effects

- Shipsheet results (with cut line)
- Cut list/results. [Ref. 7]

The user selects to consolidate results by program element. Furthermore, he selects all fiscal years to be included in the shipsheet consolidation. [Refs. 6, 7]

The screen will then display one page for each budget line within the program element. [Ref. 7]

MRS				POM DISPLAY		

Program Element: 24221 Atlantic Fleet ROH						
Null	Avail	Start	End	Mandays	FY 1994	FY 1995

CG 48	ROH	09/26/94-05/26/95	41,188	24,328,491		
CG 51	ROH	05/02/95-01/12/96	41,188			24,672,687
CG 55	ROH	10/14/97-06/12/98	41,188			
CG 56	ROH	01/20/98-09/18/98	41,188			
CG 58	ROH	10/19/98-06/18/99	41,188			
CG 60	ROH	08/13/97-04/17/98	41,188			
CG 61	ROH	06/21/99-02/21/00	41,188			
CG 64	ROH	10/26/98-06/26/99	41,188			
CG 66	ROH	09/20/99-05/20/00	41,188			

The total cost is listed by fiscal year. Scrolling down to McInerney and moving right (< --->), the user finds the dollars for the FY97 DSRA. Scrolling to the bottom he can review (in thousands of dollars) the total budget requirement for each year in the POM. [Ref. 7]

		FY 1994	FY 1995	FY 1996	FY

GRAND TOTAL					
OVERHAUL (000)	LANT	127,738	69,255	367,082	72
	PAC	89,334	37,010	135,946	363
	Total	217,072	106,266	503,029	435
SCHEDULED RATE (000)	LANT	531,639	479,663	624,067	632
	PAC	517,274	746,726	630,196	664
	Total	1,048,913	1,226,389	1,254,264	1,297

Now the user wants to assess the funding cut by examining McInerney's shipsheet with the cut line. By backing out to the "Assessing funding cuts" menu and selecting "shipsheet results (with cut line)," he can examine the impact of this 10 percent cut on the USS McInerney's 1997 DSRA. The screen will display the shipsheet in descending order of risk.

[Refs. 6, 7]

=====					
MRS			MCINERNEY, FY 1997, DSRA -		
=====					
Availability Title: MCINERNEY, FY 1997, DSRA - OFFICIAL					
Repair Activity: SUPSHIPS JACKSONVILL			Ship Name:		
Ship Class: FFG 7			Hull Number:		
Availability Type: DSRA			Man-Day Rate:		
Sched Begin Date: 10/17/96			Sched End Date:		
SWLIN	SWLIN Description	Mission	MCC_EAI	MDays	C
04211	Program Management			456	
10011	Temporary Hull Access	This is the shipsheet in		128	
19211	Compartment Testing	descending order of risk.		77	
40711	EMI Survey			30	
44621	TEMPEST Inspection			30	

Scrolling down the user will eventually come to the cut line. The items above the cut line represent the types of jobs for which there would be adequate funding if this 10 percent cut were made. The items below the cut line show

those types of jobs which could not be funded. In addition to the shipsheet data, this screen also shows mission elements affected (see Appendix A for valid values). Items below the cut line will likely have some impact on the mission if they are not accomplished. The degree of impact is illustrated by a mission criticality code (MCC). This represents the most severe CASREP that failure of this equipment would produce. [Refs. 6, 7]

62111 Non-Structural Bulkhead	NCO	1	I	46	26
62212 Floor Plates		1	I	72	27
62311 Ladders, othe	We have scrolled down to	1	I	22	27
62312 Ladders, othe	the 10% cut-line.	1	I	51	27
62411 Non-Struc Clo		1	I	89	27
62412 Non-Struc Closures (Non	NCO	1	I	84	27
63111 Bilge Painting	MOB	2	A	539	27
63112 Interior Painting, Mach	MOB	1	A	569	28
63113 Interior Painting, Non-	MOB	1	I	345	28
64311 Living Spaces	MOB,NCO	1	I	308	29
52211 Sea Water Sprinkling Sy	SAFETY,AAW,ASW,ASU	2	A	18	29
CUT					
58321 Lifesaving (not boats)	FSO,MOB,NCO	2	I	15	29
76311 Small Arms & Pyrotechni	SAFETY,FSO,NCO	1	A	21	29
2411X Prop. Reduction Gear	AAW,ASW,ASU,FSO,MOB	3	E	134	29
2441X Prop. Shaft Bearings	AAW,ASW,ASU,FSO,MOB	3	E	414	29
2621X Main Lube Oil Piping	MOB	2	E	44	29
3241X Switchgear & Panels	(ALL)	2	E	508	30

MRS will then provide an impact statement that is specific to the shipsheet being examined. For example, a 10 percent reduction in funding severely impacts maintenance requirements to mobility, quality of life, and environmental protection. [Refs. 6, 7]

MRS	MAINTENANCE REQUIREMENTS SYSTEM	02/28/92
<p>IMPACT STATEMENT (Example)</p> <ul style="list-style-type: none">o A 10% reduction in funding severely impacts maintenance requirements related to mobility, quality of life, and environmental protection.		
NEXT - <ENTER>		PREVIOUS - <BACKSPACE>
GLOSSARY - <f1>		QUIT - <f10>

III. CURRENT ISSUES: CREDIBILITY

Chapter III investigates the current issues relating to MRS. Section A looks at differences between MRS man-days and OPNAVNOTE 4700 notional man-days. Section B examines irregularities in man-day costing used by MRS and the BAM. Section C discusses the latest MRS software enhancements.

At the present time, MRS meets the goals and objectives as they are delineated in DoD Directive 5000.2 by projecting ship maintenance requirements and articulating the impact of less than full funding for them. MRS projects requirements listed in line items P2F1 and P2F2 under the activity group General Purpose Forces: Ship Maintenance in the OM&N appropriation. [Refs. 7, 8] Putting this into perspective, Ship Maintenance is the largest activity group under General Purpose Forces. An average of 34.8% or 1.3 billion dollars of surface ship maintenance are examined by MRS for the POM and the budget on the basis of mission priorities and system performance.¹⁵ [Refs. 7, 8] Specifically, the probability of failure and the severity of failure define the risk associated with not performing depot level maintenance and the subsequent impact on mission performance (i.e., a performance budgeting system). Performance budgeting, in the form of MRS, represents 6% of

¹⁵Based on FY 1994 and 1995 figures.

the OM&N appropriation and 1% of the entire Navy budget for fiscal years 1994 and 1995. [Refs. 7, 8]

With any budget tool, credibility is of paramount importance. If credibility is called into question the tool may no longer be helpful. The credibility of a performance budgeting system is based upon the integrity and honesty of the underlying mechanics/methods [Ref. 9]. To facilitate system development and address problems associated with the mechanics of MRS, a MRS Users Group was organized by the director of surface ship maintenance at NAVSEA (Code 915) and the membership made up of PERA (SURFACE), both Atlantic and Pacific fleet, and surface type commander material officers. Other members include representatives from the Office of the Chief of Naval Operations (OPNAV): Director Surface Warfare Division (Platform Maintenance Branch N-865X) and Director Support Maintenance and Modernization Divisions (N-43). The Users group identify, research, and contribute to the system development process. These strategy sessions solve problems and enhance acceptance by ensuring MRS integrity and credibility.

The first MRS Users Group meeting was held in February 1991. There have been eight meetings since then, with the latest on 3 March 1993 [Ref. 10]. [See Appendix B for overall system development time line] The following sections of this chapter detail current issues and proposed solutions relating to the utility and credibility of MRS.

A. MRS REPRESENTATIVE AVAILABILITIES AND THE OPNAVNOTE 4700 NOTIONAL MAN-DAYS: CURRENT DIFFERENCES

The December 1992 OPNAVNOTE 4700 contains the man-days used for programmed availabilities (the notional man-days contained in the 4700 NOTE are derived from MRS for surface ship availabilities and Class Estimating Standards (CES)¹⁶ for submarine availabilities. These notional man-days are used: in the Baseline Assessment Memorandum (BAM) costing methodology, in FLEET POM submits, and by FLEETs and TYCOMs to set funding caps on availabilities). One hundred nine surface ship availability types are delineated in the OPNAVNOTE 4700 (e.g., Docking Phased Maintenance Availability-DPMA, Docking Selected Restricted Availability-DSRA, etc.) and their respective notional man-days. Only 14 MRS representative availability man-days from the 9 October 1992 data-the most current-are reflected in the OPNAVNOTE 4700: another 58 have man-days from February 1992 MRS data and 27 have pre-MRS man-days. Furthermore, MRS treats AD14/37 and 41 ship classes separately: OPNAVNOTE 4700 treats them as one. Also, MRS calculated LCC 19 availabilities based on the past and future CNO schedule (two availabilities per fiscal year). However, the OPNAVNOTE 4700 contains a footnote which says to consider every two LCC 19 availabilities as one. [Ref. 9] (In this

¹⁶Created for submarine maintenance planning (both the 687 and 688 class), the Class Estimating Standards (CES) were designed to 1) help naval shipyards control cost 2) standardize the estimating base and 3) aid in budget development. CES does not perform a risk assessment nor does it show the impact of under funding the work package. [Ref. 10]

case the MRS man-days should be doubled in the OPNAVNOTE 4700).

These differences give rise to three distinct problems. First, once the budget analyst compares the MRS and OPNAVNOTE 4700 man-days, loss of credibility could lead to the loss of both current and programmed funding. Second, MRS impact assessments may be less useful due to the fact that MRS is starting from different totals than the Baseline Assessment Memorandum (BAM - provides for the costing of the ship depot maintenance program for the six year period covered in the future years defense plan (FYDP). Additionally, the BAM identifies prior year expenditure requirement for availabilities that start one or two years beyond the FYDP). Thirdly, from a long-term perspective, budgets for individual availabilities will be built without the best (substitute credible) data. [Ref. 9]

The Users Group discussed and analyzed matters relating to this situation and their implication to the POM and budget. Consensus of the Users Group was achieved on the following points:

1. Publish the next OPNAVNOTE 4700 in September 1993. In support of this:

- Prepare the next MRS data by 1 July 1993
- The Users Group will review the results of the data development to ensure that the process is producing reasonable and converging man-day estimates (i.e., that the difference between the average Representative Availability man-days of the MRS data sets is declining from year to year)

- The MRS man-days will be submitted to OPNAV on 1 August 1993 for inclusion of all MRS man-day estimates in the OPNAVNOTE 4700 update
- OPNAV will coordinate change promulgation with the FLEETs and TYCOMs. [Refs. 9, 10]

2. The updated OPNAVNOTE 4700 and all subsequent updates to the notice would include the caveat "... for use in FY96 and latter years" [Refs. 9, 10] The intention of this is to avoid a disruptive budget impact in the current and next years.

3. In the future, new MRS man-days should be distributed only during POM development years. If POM development is required in an unpredictable manner, new MRS Representative Availability data will be generated annually by 1 July and forwarded to OPNAV for POM development. This action attempts to ensure that validated program changes coincide with the budget [Refs. 9, 10]. Additionally, all of the latest (most recent) MRS man-day estimates will be incorporated into the OPNAVNOTE 4700.

To facilitate the acceptance of a periodic update to the OPNAVNOTE 4700, the User Group consensus is that key personnel in both the POM and Budget process require an understanding of two fundamental, albeit conflicting, development issues:

- The MRS process is the best way to achieve an honest, credible and defensible POM (i.e., a thorough understanding of what and how MRS works: including a demonstration of the capabilities of MRS)
- Since the MRS process hinges upon the feedback of actual condition-based maintenance data, man-days will vary.

With regard to the best way to achieve an honest and defensible POM, MRS provides a solid, technically engineered, method to measure the relative risk of not fully funding surface ship maintenance, and portrays the impact on mission performance. However, a "catch-22" is present in the need to provide a smooth projection of requirements to budget analysts in the comptroller's office (i.e., in the Navy -NAVCOMPT- and Office of the Secretary of Defense (OSD)). Initial Representative Availabilities will have larger standard deviations associated with their data sets, a normal occurrence with any developmental performance budgeting system such as MRS. As more availabilities (i.e., Completion SARPs) are included into the data base used to generate a Representative Availability, the standard deviation should be dampened. Therefore, variances in man-days (from Representative Availability to Representative Availability) will decrease. Thereby, more accurate reflections of the cost (represented in this hypothesis in man-days) of the condition-based maintenance philosophy will be produced.

The spikes and valleys in program requirements generated by a developmental performance budgeting system evoke skepticism in resource sponsors and budget analyst. Budget analysts are motivated to protect resources for programs that obligate resources in a timely fashion and execute budget authority on a steady basis. Performance budget systems that do not immediately (within a short period

of time, 12 to 36 months) produce stable projections are subject to failure. Temporary fixes (such as partial updates, splitting the difference in man-day differences, or assigning arbitrary percentage factors) to avoid spikes or valleys only accentuate the inconsistencies between the actual budget and a plan based upon feedback of actual expenditures. This may be viewed as a critical issue related to the success of MRS.

The Users Group has reached consensus to resolve other inconsistencies noted as follows:

- PERA (SURFACE) and Logistics (CNO N43) will jointly determine whether the differences between AD 37 and AD 41 ship classes warrant a separate representative availability
- Additionally, they will ensure that the historical basis for special availability strategies (e.g., LCC 19) are clearly articulated and consistent in both MRS and OPNAVNOTE 4700. [Refs. 9, 10]

The definitive actions/procedures will be discussed at the next Users Group meeting in July 1993.

B. ADVANCE PLANNING AND FARM-IN/FARM-OUT BAM FACTORS

In October 1992, the Users Group reached a consensus that the MRS data development (MDDS)¹⁷ process should develop not only the OPNAVNOTE 4700 notional man-days, but also develop recommendations for the Advance Planning (AP) and Farm-in/Farm-out (FIFO) factors in the BAM. This would provide an independent feedback into the generation of these factors. [Ref. 10]

¹⁷For an in depth discussion of the MRS data development process see Appendix C. [Ref. 12]

1. MRS and BAM Factors: Current System

The BAM defines Advance planning (AP) as " ... the historical percentages of the availability costs associated with work package development" [Ref. 11] The BAM further defines Farm-in/Farm-out (FIFO) as " ... the historical percentages of the availability costs contracted outside the shipyard for ship systems repair. FIFO costs are in addition to the yard costs and are considered elective by the TYCOM. As a result, FIFO factors are capped at 4%. If a TYCOM chooses to Farm-out greater than 4% of an availability's work package, it should reduce the man-days accordingly" [Ref. 11]

MRS and BAM factors currently use the following formulas to price out an availability:

Labor Cost	=	MD x MD Rate
Material Cost	=	MD x Material Rate
AP Cost	=	AP x Labor Cost
FIFO Cost	=	FIFO x Labor Cost
Total Cost	=	Labor Cost + Material Cost + AP Cost + FIFO Cost

where: MD = (Man-days from OPNAVNOTE 4700) MD Rate = (Man-day rate from N80)

Material Rate = (\$84.00: from N80, same for CVs, SUBs, & SURF) [Ref. 11]

2. Problems With Calculating AP and FIFO From Current Data

The MRS data scatter using current MRS data resulted in the following:

AP (0 - 36%) an average of 10%

FIFO (0 - 13%) an average of 4%

The average AP factor (i.e., 10%) is more than three times the factor used by carrier and submarine maintenance planners (i.e., 3%). While 10% may be close to the real average for Advance Planning costs, the BAM definition of AP is narrower (i.e., work package development costs). [Ref. 9] For example, Advance Planning Tasks for the Phased Maintenance Program (PMP) include 63 distinct activities conducted by six independent organizations [Ref. 13].

The problem lies in the disparity between the definition of AP (cost associated with work package development vs. all advance planning tasks) and the derivation of the FIFO factor (specifically the FIFO factor is based upon costs associated with where work was performed vice the actual maintenance requirement) [Ref. 10].

If AP and FIFO costs are not accounted for in excess of the current factors, MRS man-days combined with the BAM costing methodology will result in a shortfall.¹⁸ The process of creating man-days for a Representative Availability from historical SARPs will drive the MRS man-days lower in each iteration of representative availability data development. In other words, work that is contracted out (farmed out) in excess of the 4% cap will lower the man-days for that availability. Additionally, the 10% average AP factor

¹⁸If AP Cost include production work items then MD is lost and if FIFO Cost is capped at 4% then MD is decreased, therefore: Total MD for third availability < second availability < first availability.

includes labor and material costs that should be represented in the man-days for the availability (e.g., long lead time material (LLTM), Prefabrication, Gas freeing, just to name a few). [Ref. 13]

3. User Group Recommendations

The potential benefits from reconciling AP and FIFO accounting include:

For the TYCOM:

- Eliminate the downward spiral in Representative man-days
- Eliminate the potential FIFO penalty
- Full cost will be reflected in the completion SARP.

For OPNAV:

- FLEET POM/BUDGET submissions more defensible
- More consistency in MRS year to year
- POM correct amount for surface ship maintenance
- Consistency of POM/BUDGET justification among, FLEET, TYCOM, & SPONSOR.

For PERA:

- Retain flexibility of TYCOM payments to/via PERA for tasks other than SARP preparation
- Easier to complete MRS data development process. Fewer factors to screen for lost man-days, simpler reconciliation process.

For NAVSEA:

- Simpler maintenance data development system (MDDS)/MRS process
- Ease of defense of and consistency with the BAM
- Accurate POM should increase probability of correct funding for proper repairs. [Ref. 9]

The User Group has decided on four actions in response to AP and FIFO anomalies.

1. Instead of the current Advance Planning data in MRS, PERA should identify actual work package preparation costs to validate the AP factor. This will more accurately reflect the historical man-days reflected in work package development mentioned in the BAM.
2. Furthermore, PERA should capture and identify all availability costs, including advance planning and farm-in/farm-out in the completion SARP. Advance planning costs in the SARP should be identified as one of two categories: work package preparation or other. This attempts to ensure a more accurate reflection of an availability's total maintenance requirement costs. Additionally, this should avoid the possibility of losing track of those costs and inadvertently creating the downward man-day projection during the iterative process of generating a Representative Availability.
3. Farm-in/farm-out cost should be included in man-days and material costs in separate work items of the MRS Representative Availability and not accounted for separately as a factor. This should provide a method of attaching costs directly to the cost driver, giving additional granularity to the total maintenance requirements.
4. Advance Planning costs (except for work package preparation) should be included in MRS Representative Man-days. This too, should help to ensure that actual maintenance requirements are accounted for in an availability and reflected in the man-day projections. [Refs. 9, 10]

C. IMPLEMENTING CONSISTENCY IN MRS VERSION 2.0

The MRS project manager from American Management Systems, Inc. has briefed The Users Group on the enhancements currently in the MRS Version 2.0 software ready for the next release. The Users Group concurred with the requirements for the following:

1. Flexible POM year selection (in version 1.1 the user only has access to the current POM year, with flexible POM year selection the user can tailor shipsheets using

the most recent POM data for any year covered in the Future Year Defense Plan (FYDP). The user will be able to look at the impact of Program changes on the current and budget years in addition to the years covered by the POM).

2. Shipsheets for all future availabilities in FMPMIS (this modification will allow the user to review any availability that is in the FMPMIS data base in a shipsheet format. The user will be able to conduct budget/program sensitivity analysis on any shipsheet.
3. Use of BAM factors for:
 - Advance funding (funds required for prior year expenditures relating to ship overhaul), Advance Planning (work package development costs), Farm-in/Farm-out (this will be zeroed), and Material (only for availabilities with out a MRS Representative Availability, i.e., newly constructed ships placed into a maintenance cycle, for example, MCM 1 AVENGER class and MHC 51 OSPREY class mine warfare ships). This enhancement will establish more consistency between MRS and the BAM.
4. Display SWLIN line item information as an option in Tailor Shipsheets. This option will allow the user to review and modify all the various line items under a given SWLIN, providing additional granularity.
5. Alteration handling:
 - K Alteration (K-ALT) schedules will be loaded from Fleet Modernization Program Management Information System vice manually tagged to each availability. These can be used to call the user's attention to the effect of K-ALTs on other work in a specific availability and help tailor the effect of the K-ALT. For example a K-ALT may require the replacement of an entire system (e.g., the forward 5 inch MK 45 gun mount on a SPRUANCE DD 963 class) with a new system (vertical launch system (VLS). The user can eliminate maintenance requirements associated with the old system, thereby precluding double counting.
 - Actual D & F alteration estimates can be loaded from FMPMIS and used instead of the MMMMM SWLIN averages. This option will provide a more accurate estimate based on actual D & F alteration experience (learning curves) vice an average of all D & F alterations. [Refs. 9, 10]

It appears that the ties between MRS and performance budgeting have been accepted in the development of the POM by the TYCOMs, FLEETs, Resource sponsor, and Program manager for surface ship maintenance. MRS has been recognized and brought forth to justify the 1994 fiscal year budget by the Office of the Comptroller of the Navy (NAVCOMPT) as a definitive way to "... [define] Baseline Assessment Memorandum (BAM) requirements for maintenance [which] has allowed the surface Navy to specify maintenance requirements by ship class across the FYDP (future years defense plan) [Ref. 14]. However, after reviewing the current issues and stage of development, (i.e., differences in: MRS and the OPNAVNOTE 4700 man-days, the BAM's (i.e., AP and FIFO) ability to capture the correct costs), NAVCOMPT may resort to the steady, incremental approach of budgeting based upon their reluctance to support variances that come out of MRS. How can this be defended before NAVCOMPT? The answer appears to be to educate them about MRS and performance budgeting.

The fourth chapter outlines the future challenges MRS faces and action by Congress through "The Government Performance and Results Act" (S.20) that would attempt to initiate a new form of accountability within government programs through the use of performance budgeting techniques.

IV. FUTURE ISSUES: PROJECTING PERFORMANCE AND COMPLIANCE WITH PUBLIC LAW

The purpose of Chapter IV is to explore three future issues facing MRS. Section A examines how MRS compares with proposed federal regulations dealing with performance measurement and budgeting called for under the Government Performance and Results Act of 1992. Section B lays out the time line for major milestones called for under the Government Performance and Results Act. Section C examines the last issue: the proposed expansion of the MRS projection and justification technique to include other surface maintenance resources.

A. ELEMENTS OF PERFORMANCE MEASUREMENT SYSTEM: KEY ELEMENTS AND SIMILARITIES TO MRS

According to the Senate Committee on Governmental Affairs as prescribed in the Government Performance and Results Act of 1992, the building blocks of an effective performance measurement system are:

- Strategic plans,
- Annual performance plans,
- Annual performance reports. [Ref. 15]

1. Strategic plans are required to provide the starting point and desired end point or destination in the future in terms of program goals. A strategic plan is necessary to implement the overall organization's mission. [Ref. 15]

MRS is based upon the following strategic goal:

... Include adequate funding in budget requests to meet system readiness objectives and identify the readiness impact of failing to provide the requested funding
[Ref. 3]

It is important that strategic goals be clearly understood and defined. This is especially true in organizations with a high turn-over rate in managerial positions. [Ref. 15] For example, only three out of ten members of the MRS User's Group have been involved with MRS since its development.

2. Annual performance plans should link daily operations to the strategic goals [Ref. 15]. MRS projects maintenance costs of scheduled depot level maintenance for overhauls (i.e., ROH, COH, etc.) and scheduled RATA based upon extensive inspections and the collection of historical maintenance data conducted during maintenance planning. By using the processes described in chapter II (i.e., defining requirements, projecting requirements to support budgeting, and managing risk in a constrained funding environment), MRS supports the achievement of the strategic goal of maximum surface ship readiness. MRS also shows the impact on readiness defined by the mission criticality code (MCC) as a result of a reduction to the surface ship maintenance program on any given ship down to the system level of detail.

3. Annual program performance reports provide feedback to managers, policy makers, and potentially even to Congress and the public as to what was actually accomplished for the

resources expended-i.e., to what extent and how well the original goals were met. [Ref. 15]

MRS takes into account program performance reports in the form of feedback from the following sources:

- 3M Maintenance and Material Management System quarterly reports
- CASREP Equipment Casualty Reports
- MRMS Maintenance Resource Management System
- INSURV Board of Inspection and Survey
- PEB Propulsion Examining Board
- CSA Combat System Assessment
- Emergent RATA Unscheduled restricted availability/technical availability
- AEC Assessment of Equipment Condition Program.

These various inspections, assessments, and reports reflect how well a ship is prepared to meet its operational commitments. However, it must be noted that MRS is used to project funding for future maintenance requirements and the impact of less than full funding. MRS does not reflect the performance of repair work at a ship yard (public or private). MRS does not take into account the level of training, experience, or expertise of equipment operators in preventive maintenance. To improve management and budget decision making the annual performance reports (i.e., outcomes) for ship yard workers and ship's force could be handled in a different manner such as, utilizing the work centers preventive maintenance accomplishment rate (an indicator of how well the

crew takes care of a piece of equipment) and the mean time between failures after re-work by the yard. All program performance reports (i.e., for the ship yard, ship, and support organization) could be reviewed in an integrated manner to determine the Navy's overall mission readiness (i.e., effectiveness). The Government Performance and Results Act asks that annual performance reports include an explanation when goals are not achieved [Ref. 15]. This element of the annual performance report is not specifically addressed by MRS. However, the reports shown above do provide narrative descriptions when passing grades are not obtained (e.g., Combat System Assessment) or where systems fail to function at desired specification levels (e.g. Propulsion Examining Board). MRS uses these reports as feedback to determine the probability of failure P_f and the severity of failure S_f ; this quasi-automatic mechanism provides a self correction to MRS projections.

The Government Performance and Results Act offers the possibility of waivers for increased managerial accountability and flexibility, and it suggest the need for development of program performance budgets. The Committee on Governmental Affairs recognized the limitations placed on federal managers in shifting resources within their programs. Instead of being accountable for results, managers are accountable for adhering to specific procedures mandated for the program. In other

words, managers are evaluated on following procedures, not on program performance. [Ref. 15]

An example of this problem is where the assigned type desk officer for a given ship undergoing an availability is not allowed to move I level funds (e.g., funds used by SIMA or CIS) into a depot level account to accomplish non-skid resurfacing on a flight deck. In budgeting this might incur a violation of Title 31 of United States Code (USC) section 1517 of The Anti-deficiency Act and/or a violation of appropriation law, i.e., the use of appropriated funds for other than their intended purpose [Ref. 16]. If the constraint implied above were to be relaxed somewhat, better program and cost decisions could be made at the appropriate level, in this case the type desk officer level. The type desk officer would also be held accountable for the performance outcome for that repair item, as well as would those who did the repair.

Presently, the decision to move resources from one account to another within a budget activity such as, General Purpose Forces: Ship Maintenance, resides at the Type Commander staff level and, consequently, requires the Type Commander to be briefed. Typically, the process begins with providing all the reasons why the work can not be funded through the normal account followed by all the reasons why the work is required. The process can take from two or three days (e.g., on a TYCOM interest item) to two or three weeks to reach a decision. Time is a most valuable resource when a

ship is in an availability. Even if the funds can be acquired to accomplish the work, the window of opportunity to accomplish the repair may be narrow or shut. Furthermore, the federal budget and resource allocation system promotes the "use it" or "lose it" approach to program execution. This approach does not address the priority of program demands for resources. MRS ranks repair work by the risk and associated cost of not funding an item. Specifically, MRS shows the most important work needed to be accomplished at the top of the priority listing followed by repair work with lower associated risk. When a reduction in funding is imposed, MRS draws a line on the list showing what jobs will not be accomplished at the proposed funding level. Additionally, MRS shows the impact on mission readiness in the form of a statement detailing the mission areas degraded by the cut.

The preceding analysis indicates that MRS fulfills some of the intent of the Government Performance and Results Act with respect to many of the key elements that the Act deems necessary for implementation of a performance measurement system.

B. IMPLEMENTATION OF THE GOVERNMENT PERFORMANCE AND RESULTS ACT

The Government Performance and Results Act is far reaching and will require federal agencies to conduct a top to bottom review of program goal-setting, performance measurement and reporting. The scope of the task requires careful planning

and thoughtful execution. The ultimate objective is to alter agency and managerial behavior, but not to create another burdensome bureaucratic information system. [Ref. 15]

The Act calls for the following time line for implementation:

October 1, 1993	10 pilot projects in annual performance plans and reports (FY 1994, 1995, 1996). This will give the Office of Management and Budget (OMB) the opportunity to study the examples and develop guidance for full scale implementation.
October 1, 1994	5 pilot projects in managerial flexibility waivers (FY 1995, 1996). These five pilots will be among the 10 mentioned above. This will see if incentives will increase the success of implementing better accountability systems.
May 1, 1997	OMB will issue reports to Congress on pilot project test findings.
June 1, 1997	GAO will issue reports to Congress on pilot project test findings.
July 1, 1997 (approx)	Joint resolutions introduced in both house of Congress, requiring phase-in government wide of the Act's performance goal-setting, measurement and reporting requirement (note: both houses would have to approve the resolution for the statutory mandate to be implemented).
August 1, 1997 (approx)	Resolution reported : voted on.
September 30, 1997	All agencies submit 5-year strategic plans (and every 3 years there after), and annual performance plans (and each year there after). submit at least 5 pilot projects in performance budgeting (FY 1998 and 1999).

January 1998 (approx)	OMB submits Federal Government performance plan with FY 1999 budget (and each year there after). The FY 1999 budget will also show pilot projects in performance budgeting in a performance budget format.
March 31, 2000	All agencies submit annual performance reports for FY 1999 (and each March 31 there after).
March 31, 2001	OMB report on performance budgeting pilot projects. [Ref. 15]

Senator William V. Roth, Jr. (R-De) the sponsor of the Government Performance and Results Act stated on October 2, 1992:

... This bill is aimed squarely at the issue of government performance... the source of much of the public's frustration towards Washington.... For the first time, agencies would have to develop specific goals for program performance, relating to efficiency, effectiveness, responsiveness, quality, and customer satisfaction.... Agencies would then have to measure and report the results annually to Congress and the taxpayers.... Any goals not met would have to be explained.... This type of reform, a systematic focus on measuring and reporting program results, is spreading throughout State and local governments here, and at the national level in several major foreign countries.... Now it looks like it might reach our own federal government, and not a moment to soon The public is angry about how government performs, and demands a real change in the way Washington does business.... This reform is just such a major change.... [Ref. 17]

Roth's legislation implements several of the key ideas advocated in the book "Reinventing Government," and has been strongly endorsed by David Osborne, the book's co-author (along with Ted Gaebler) [Ref. 17]. The Act also was an important topic of discussion during the Committee on

Governmental Affairs confirmation hearings for OMB Director designate Leon Panetta in January of 1993 [Ref. 18].

C. MRS FUTURE ISSUES

As explained in the beginning of Chapter III, MRS projected maintenance requirements on average for fiscal years 1994 and 1995 for approximately 35% or 1.3 billion dollars of the total activity group for general purpose forces: ship maintenance. Specifically, MRS projects the maintenance requirements for surface ship maintenance (i.e., overhauls (ROH, COH) and scheduled restricted availabilities/technical availabilities (RATA) [Ref. 10]. The remaining 65% or 2.5 billion dollars of general purpose forces: ship maintenance not covered by MRS represents the maintenance requirements of aircraft carriers and fast attack submarines [Ref.10]. Representatives of both the aviation and submarine maintenance communities are presently reviewing the applicability of MRS to their respective programs [Refs. 9, 10].

Although MRS projects requirements for regular overhauls (ROH) and scheduled restricted availabilities/technical availabilities (RATA), MRS does not project maintenance requirements for intermediate maintenance activity (SIMA) repair work (i.e., intermediate (I) level scope jobs, including Contractor Industrial Support (CIS)), emergent RATA or voyage repairs. This is particularly significant in view of the changing nature of ship maintenance philosophies (i.e., the move from time-directed repair to conditioned-based

maintenance and, moving further down the spectrum of maintenance philosophy, to continuous maintenance). [Refs. 9, 10]

A new policy proposal is to perform maintenance just before an equipment casualty occurs, thereby ensuring 100% readiness 100% of the time. In practice this would require flexibility in repair planning and execution best suited by SIMA, CIS, or Emergent RATA capabilities. As resources are shifted from regular overhauls, phased maintenance, and scheduled RATA as a result of reduced funding for shore based support infrastructure, the importance of projecting maintenance requirements at all levels of accomplishment (i.e., depot, intermediate, and organizational) becomes increasingly apparent in the form of operational readiness. In other words, as infrastructure is "right sized" in an effort to cut defense spending, SIMA, CIS, and Emergent RATA (maintenance resources not currently using a performance budgeting format like MRS) will determine surface ship readiness in the Navy.

The MRS Users Group recognizes the potential impact of moving away from depot level maintenance toward the shorter, more flexible method of repair offered by SIMA, CIS, and Emergent RATA called for under the continuous maintenance philosophy. The Users Group also recognizes the potential effect on overall readiness. In an attempt to get a handle on the problem, the Users Group asked that NAVSEA Code 915 try to

find a way to use MRS and the MRS Data Development System (MDDS) to project and defend Emergent RATA costs over the POM. The results of the research into the Emergent RATA question will be discussed at subsequent Users group meetings. The Users Group also must decide how to treat jobs initially screened to the depot but later re-screened to the SIMA due to insufficient depot maintenance funds. The Users Group has not agreed whether these costs should be projected as depot maintenance requirements with MRS or whether these costs are truly SIMA maintenance requirements. PERA (SURFACE) agreed to study the magnitude of SIMA work and report the results at the next User Group meeting in July 1993. However, in the mean time, MRS will not project these jobs as depot maintenance requirements to ensure that MRS credibility is not violated. [Refs. 9, 10]

It must be remembered that the purpose of MRS is to project depot (D) level repair requirements. Repair work that can be accomplished by a SIMA is, by definition, an intermediate (I) level job. The reality is that there are many system installations (e.g., MK 45 chain gun or Joint Operability Tactical System (JOTS) that would, under normal circumstances, be completed at the depot level. But, because of operational commitments, the work must be scheduled during a shorter availability and completed by SIMA, CIS, or ship's force in conjunction with the manufacturer's representative. If a system for gathering and projecting these requirements is

not developed the end result will lead to the under funding of these alternative maintenance capabilities and the subsequent backlog of maintenance repair work, i.e., the primary problem that led to the development of MRS.

V. CONCLUSIONS

This chapter provides answers to the research questions presented in Chapter I. Section A addresses how MRS is used and whether it has had a direct impact on budgeting in the Navy. Section B examines the current and future issues that face MRS in implementation. Section C points out areas for further research.

A. HOW IS MRS USED IN THE NAVY? DOES MRS HAVE A DIRECT IMPACT ON BUDGETING?

MRS systematically reports surface ship maintenance priorities for programming and provides resource justification in three distinct phases: defining requirements, projecting requirements and managing risk. MRS also evaluates the impact of funding below the requested level in terms of mission readiness, thereby allowing resource managers an opportunity to weigh the risk and potential outcome associated with resource allocation decisions.

First, MRS is used by N86 in the POM development process for surface ship maintenance cost estimation. Second, MRS is used in the budget development process at the FLEET and TYCOM to set funding caps on the cost of ship maintenance (i.e., availabilities), both in budget preparation and execution. Finally, MRS has also been used in the budget reclama process

in 1992 for surface ship maintenance dollars at the NAVCOMPT level.

B. WHAT ARE THE CURRENT AND FUTURE ISSUES FACING MRS?

A current issue that the architects of MRS are working on is to establish overall system credibility and integrity. Inconsistencies need to be resolved between:

- MRS man-days and OPNAVNOTE 4700 man-days
- MRS and BAM man-day formulation.

This issue has been addressed and the following corrective actions initiated:

Revised OPNAVNOTE 4700 update procedures:

- Current MRS man-days will be incorporated in the OPNAVNOTE 4700 and distributed only during POM development years.

Release of MRS version 2.0 enhancements:

- Eliminates discrepancies in costing factors (i.e. advance planning and farm-in/farm-out)
- Increases user flexibility for sensitivity analysis.

There are two primary future issues that MRS must address. First involves expanding MRS capability to include intermediate level maintenance, emergent RATA, and voyage repairs. The second is compliance with proposed legislation that attempts to initiate a new form of accountability within the Federal government through the use of performance budgeting techniques.

C. AREAS FOR FURTHER RESEARCH

First, in view of strategic planning in the public sector, how is maintenance being integrated across warfare community lines? Second, What is being done or can be done to improve the feedback for MRS? How integrated should the availability planning process and MRS be? Third, is MRS really projecting the actual impact on mission readiness? Past data on MRS availabilities and resultant CASREPs during the operating cycle could be analyzed and compared. Fourth, is MRS cost effective? Do all the savings in the form of resources saved from budget marks exceed the life cycle cost of MRS or the development cost of MRS? Fifth, can the MRS approach be applied to other areas (i.e., training, base support, etc.) in the Navy?

APPENDIX A

VALID DATA VALUES AND DATA DERIVATION GUIDELINES

Availability Type

<u>Valid Values</u>	<u>Description</u>
COH	Complex Overhaul
CONV	Conversion
DPMA	Docking Phased Maintenance Availability
DSRA	Docking Selected Restricted Availability
ESRA	Extended DSRA
PMA	Phased Maintenance Availability
RCOH	Refueling Overhaul
ROH	Regular Overhaul
SCO	Service Craft Overhaul
SRA	Selected Restricted Availability

Job Category

<u>Valid Values</u>	<u>Description</u>
D	Depot Routine
M	Modernization Job (valid in Tailored Shipsheet only)
O	Mandatory Override - allows user to prioritize a particular SWLIN apart from its risk values, causing the job to move to the top of the list (valid in Tailored Shipsheet only)
R	Repair Job

Mission

(NOTE: No mission capability identifier is required for non-shipwork SWLINs such as shipyard routines or advanced planning work.

Valid Values**Description**

AAW	Anti-Air Warfare
ASW	Anti-Submarine Warfare
AMW	Amphibious Warfare
ASU	Anti-Surface Warfare
ELW	Electronic Warfare
CCC	Command, Control, and Communications
MIW	Mine Warfare
LOG	Logistics
INT	Intelligence
FSO	Fleet Support Operations
MOB	Mobility
NCO	Non-Combatant Operations
SAF	Safety
ALL	Affects All Missions

Mission Criticality Code (MCC)**Valid Values****Description**

1	Failure of equipment would result in C-1 CASREP
2	Failure of equipment would result in C-2 CASREP
3	Failure of equipment would result in C-3 CASREP
4	Failure of equipment would result in C-4 CASREP

EAI

One of three letter designators is assigned to each SWLIN that categorizes the proposed work as essential (E), advisable (A) or insurance (I). The criteria for each category are shown below.

<u>Valid Values</u>	<u>Description</u>
E	Essential Work
--	"legislated" work from NAVSEA Technical Manual (NSTM) or other technical authority
--	Class Maintenance Plan (CMP) work requirements for MCC-3 & 4 systems or equipments
--	work that can be done <u>only</u> in the depot
--	mandatory shipyard routine items
--	mandatory advance planning work items for the availability
A	Advisable Work
--	all other MCC-3 & 4 work
--	MCC-1 & 2 work with high probability of failure
--	other justifiable work (e.g., habitability requirements)
I	Insurance Work
--	MCC-1 & 2 work with a low probability of failure
--	work accomplished early because its engineered periodicity does not match availability scheduling (accomplish early rather than late)

- complete rework (including change out) authorized in lieu of selective repair because depot capability to deal with growth in scope is limited (where this can be determined on a ship class basis)
- work accomplished early because pre-availability condition inspection combined with material condition trend indicates failure will occur before next scheduled availability

SEVERITY

Table A-1 was used for determining values for severity of failure S(f). This table stratifies consequences of failure into four levels and assigns descending values for severity of failure accordingly:

- | | |
|-----------------------|---------------------|
| 1. Safety | 3. Repair Economics |
| 2. Mission Capability | 4. Other |

The table follows reliability-centered maintenance decision (RCM) logic which recognizes the difference in importance of the four different types of failure consequences.

The table is used by first determining whether the failure poses a direct and adverse threat to personnel safety, the same entry point used in the RCM decision logic. If "Yes," failure severity is 100. If "No," the consequence of failure on mission capability is considered next. In this step, further consideration is given to whether a primary or secondary mission area is involved, whether the effect is

complete loss or degradation of the mission area, and whether other systems are or are not affected by the failure (independent or associated failure).

If the failure does not affect personnel safety or ship mission area, it may still be the type of failure that must be corrected by the depot or is most economically repaired within the confines of the depot where necessary facilities are close at hand, or where depot capabilities may be brought to the ship. This is category 3 of the table.

There are other remaining failures which do not affect safety or mission capability and for which there is no compelling reason for depot repair. This is category 4 of the Table.

PRIORITY	CATEGORY OF FAILURE EFFECT	SEVERITY FACTOR
----------	----------------------------	-----------------

1	Personnel Safety	100
---	------------------	-----

2	Ship Mission Capability	
---	-------------------------	--

Effect On Mission Areas Systems	Mission Effect	Effect On Other	
Primary/Secondary	Loss/Degradation	Yes/No	
XX	XX	XX	90
XX	XX	XX	88
XX	XX	XX	85
XX	XX	XX	82
XX	XX	XX	78
XX	XX	XX	74
XX	XX	XX	70
XX	XX	XX	66

3	Repair Economics	
---	------------------	--

Failure Requires Depot Facilities For Correction	60
--	----

Failure Does Not Require Being Physically Located In a Depot But Requires Depot Personnel or Facilities for Correction	55
--	----

Failure Does Not Require Depot Facilities of Personnel for Correction But Work Can Be Done Most Economically During Assigned Availability in Depot	40
--	----

4	Other Remaining Failures	30
---	--------------------------	----

** To use this table, identify the effect of failure and
locate the failure severity value that corresponds to
that effect.

Table A-1

PROBABILITY

The probability of failure $P(f)$ for each SWLIN represents the likelihood systems or equipments covered by those SWLINS will fail during the period between the budgeted availability and the next scheduled availability when the work could be accomplished as a result of work being deferred. If the work

can only be done in dry dock, the probability of failure would cover the period between dockings. If the work can only be done during regular overhaul, the period covered would be overhaul to overhaul. If the work could be done during an SRA, however, the probability of failure would cover the period between the SRA being budgeted and the next scheduled depot availability whether it be an SRA, DSRA or ROH.

ADDITIONAL GUIDANCE FOR DETERMINING $S(f)$ AND $P(f)$

1. **Redundant Systems:** In order to take the most conservative approach, treat severity and probability separately for redundant systems. For severity, assume that all redundant equipments in a system fail simultaneously. For probability, use the probability of the most significant individual equipment failure.

2. **Distributed Systems:** Distributed systems fall into four basic categories: hull and structures, electrical distribution, damage control systems, and equipment cooling systems. Each of these categories affects mission areas in significant but not easily identifiable ways. While this presents problems in determining the severity of failure, the process for determining the probability of failure is similar to the process for discrete systems. The following is additional

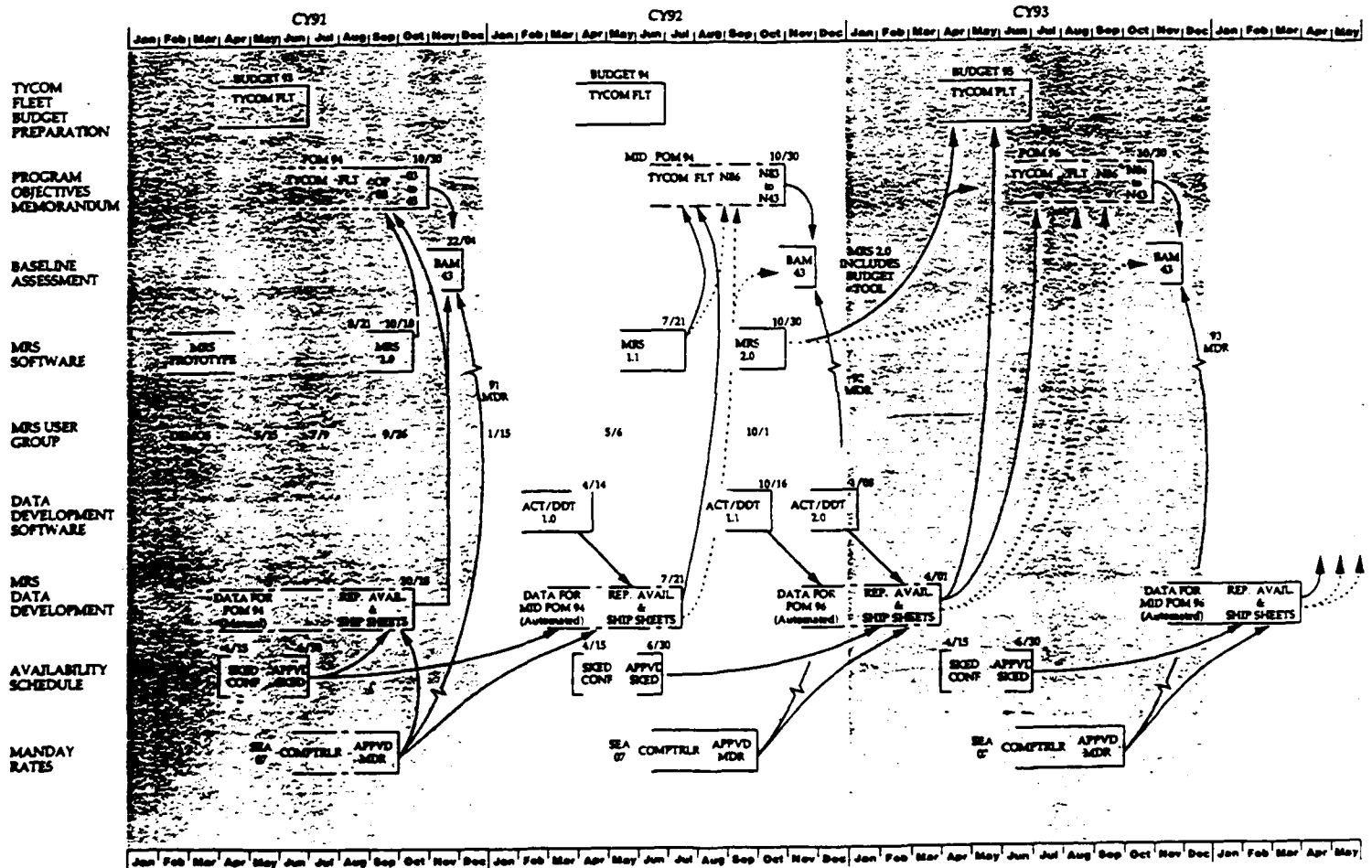
guidance for determining severity of failure in distributed systems:

- a. Hull and Structures: Those repairs which are required to ensure watertight integrity are treated as effects on a primary mission of the ship. All other hull and structural repairs are treated as effects on a secondary mission.
 - b. Electrical Distribution: Electrical distribution is treated as a primary mission of the ship.
 - c. Damage Control: Damage control is treated as a primary mission of the ship.
 - d. Equipment Cooling Systems: In general, the loss of equipment cooling is considered a degradation of primary mission. However, with some equipments on some ships, loss of equipment cooling can cause a loss of a primary mission.
3. Support and Piping Systems: In general, support and piping systems are assigned a severity commensurate with the degree of degradation that a failure would cause to their parent systems.
4. Personnel Safety: The severity factor of 100 is assigned only when personnel safety is involved. A "personnel safety" failure is one which harms people directly at the time of the failure - and as a result of the failure: for example, by

spraying shrapnel or noxious fumes. If the failure would only harm people if some unrelated problem takes place at the same time, it does not deserve this weighting factor. For example, a combat system failure that permits enemy missiles to hit the ship is not considered an "unsafe" failure for the purposes of depot repair risk assessment, because no repair job can prevent someone from shooting at the ship. A combat system failure that injures a watch stander as a result of the failure mode - is considered an "unsafe" failure, because a repair job can prevent the failure from injuring the crew.

5. Level of Repair: Failures which do not require depot level repairs are not given severity codes greater than 50.

APPENDIX B **MRS DEVELOPMENT TIMELINE**



APPENDIX C

MAINTENANCE REQUIREMENTS SYSTEM DATA DEVELOPMENT SYSTEM (MDDS)¹⁹

The Maintenance Requirements System Data Development System (MDDS) is an automated tool which produces Representative Availabilities for the Maintenance Requirements System (MRS). To accomplish this, MDDS takes historical information from SARPs, departure reports, and total costs. The SARP data is correlated to a Standard Line Item Structure (SLIS). The departure reports and total cost information are used to determine the Final man-days and costs of the availability. These man-days and costs are distributed over the SARP into a SUMMARY file. The SUMMARY File is used to create an average for each ship class/ availability type combination. MDDS then allows engineering review to ensure that the historical information is accurate and consistent. When this review is complete, MDDS creates a Representative Availability for each availability type for each ship class. This information is passed to MRS for use in Projecting future maintenance requirements.

¹⁹Information contained in this appendix comes from the MDDS Version 1.0 User's Manual. [Ref. 12]

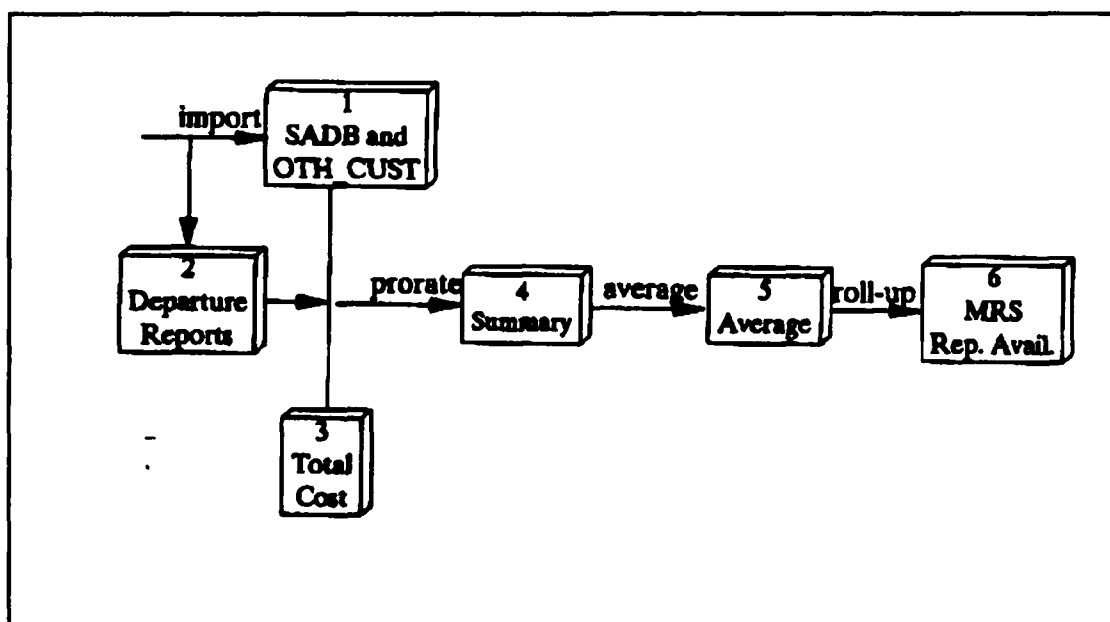


Figure 1 Data Structure

MDDS Data resides at six levels as shown in Figure 1:

- 1) SADB and Other Customer: Original SARP line items.
- 2) Departure Report: SWLIN level departure reports from the PERA Corporate History Database.
- 3) Total Cost: Total Availability Return Cost Data and TYCOM Ledger data.
- 4) Line Item SUMMARY File: Prorated MRS line items
 - Correlated SARP line items are rolled up and prorated with the best return cost data
- 5) DDT Line Item AVERAGE File: Averaged MRS line items
 - Summary file is averaged by Ship Class and Availability type.
- 6) MRS Representative Availability: SWLIN level
 - Sum of Man-days/Material times Frequency of Repair for each SWLIN in the DDT Line Item Average File.

Functions

Import

The MDDS import function takes historical SARPs and Departure reports from the PERA (SURFACE) SARP system and corporate history database and converts them into a relational database format.

Prior to running import, the SARP files must be downloaded to the PC and named with the class type, an underscore, and the four digit reference number, a dot, and the data type. For example, AD_0001.SA stands for the authorized SARP for destroyer tender reference 0001. The SARP Information menu button in the import function will decode this and display the information to the screen.

As the SARP is being imported, the line items are divided into two databases. The SADB (SARP Analysis Database) contains all of the TYCOM funded repairs which were accomplished by the Shipyard or Government Activity. The OTHER CUSTOMER Database contains all other jobs (e.g., NAVSEA funded, not accomplished, alterations, IMA screened etc.)

After a SARP is imported, the description of the problem and recommended repair (Block 35) is compared to a standard set of line items (SLIS) through the Auto-correlate process. The SLIS line items have been defined with keyword sets which uniquely identify the work. Synonyms are entered for those keywords which appear in different forms or as abbreviations. The auto-correlate process checks the Block 35 description for

each keyword (or its synonym) in each SLIS line item key set until a match is found for all keywords in a key set. If no match is found, the SARP line item is left for manual correlation.

Correlate

The correlate function allows the user to review each SARP line item and review or select the proper SLIS Line Item it correlates to. There are two main functions within correlate: Manual Correlate and View Auto-Correlation.

Manual Correlate allows the user to deal with SARP Line Items which were rejected by the automatic correlation process, or uncorrelated manually. Within the Manual Correlate function, the user can change the SLIS or its keywords and synonyms and then try the auto-correlation again. Alternatively, the user can manually choose which SLIS line item to which the SARP line item should correlate.

View Auto-Correlation allows the user to review the correlation within an availability, uncorrelate those items with are improperly correlated, and jump directly to Manual Correlate to fix the correlation. The View Other Availabilities allows the user to review all the line items for one SWLIN across availabilities. This enables the user to check the consistency of the correlation process.

Prorate and Average

The prorate and average functions operate back-to-back. First, the prorate function takes the correlated SARP data and

distributes the total man-days and material dollars from the chosen source to create the SUMMARY (or Item History) database.

After the SUMMARY database is created, the user is prompted for an anomaly threshold. Anomalies are line items from the SUMMARY database which differ from the AVERAGE line item by more than the threshold amount. Thresholds can be defined as a man-day difference, or as a percent (which also considers material cost).

After the user chooses an anomaly threshold, the selected availabilities are averaged together to form the line item AVERAGE database. A note then is added to each existing AVERAGE line item detailing the changes made.

After the initial prorate and average operation, any change to the SADB or Total Costs which affect that availability type, will trigger a pending proration flag. To clear a pending proration flag, the system administrator must re-prorate that ship class/availability type. Unless the change is minor, or does not affect the average, the system administrator should also re-average the ship class/availability type.

Caution: A re-average will recalculate all the values in the average database for that ship class/availability type. All previous values will be captured in the note. However, to avoid significant rework, perform all functions

affecting the proration before performing
Tailor Line Items.

The prorate and average function allows the system administrator to select the availabilities which will be averaged, and the source of proration data to use. However, the system will default to those availabilities which meet the criteria specified by the MRS User Group. The system administrator should be prepared to defend any deviations from these criteria. The criteria are:

- All availabilities for the past three years
- If data is available on less than five availabilities of a given type, continue back until five availabilities are found
- Do not use any availabilities more than ten years old.

The TYCOM ledger normally will provide the best, most complete source of proration data. If the TYCOM ledger is unavailable, or if a better and more complete source of data is available (such as a SWLIN level departure report), then the system administrator should choose the return cost or departure report options. If no return cost data is available, the SARP can be processed without proration. Avoid processing the SARP without proration, since the SARP estimates historically have underestimated the actual cost of reps.

Analysis

The Tailor Line Items function allows the user to review the averages for each 5115 line item for a ship class/availability type. The intent of this review is to ensure consistency and accuracy of the data. Specifically, the planners and engineers should check to see if the line item reflects work which could reasonably be expected to occur in the future, and that the SARP man-days and material costs contain no gross errors. The Tailor Line item function has several features which allow the user to review historical data. The Item History function allows the user to review the line item in SUMMARY database for each availability of that type, or for all availabilities in the database. From the Item History function, the user can choose to exclude abnormal jobs from the average or include a broader range of jobs in the average. The View Correlation option jumps to the View Auto Correlation function and allows reviewing the actual SARP work statements and the correlation. If the correlation is wrong, it can be changed directly from this function, without affecting the proration.

Create/Tailor Representative Availabilities and Add P(f)

Create Representative Availabilities and Add Probability of Failure (P(f) functions take the results of the Tailor Line Item function and roll them up into an MRS Representative Availability. The Tailor Representative Availability Function

allows reviewing and editing the Representative Availabilities.

A Representative Availability lists the average man-days and material cost for each Ship Work List Item Number (SWLIN), a system-level breakdown of the work accomplished on a ship. Additionally each SWLIN is annotated with the missions affected if that system were lost, the criticality of that mission, the relative severity if the system were lost, and the probability that the system would need depot-level repair prior to the next scheduled depot availability if the maintenance on that system was not accomplished. This information is passed to MRS for use in projecting future maintenance requirements.

Utilities

The utilities include reviewing and editing all databases, producing reports, duplicating availabilities to allow averaging similar availability types together when actual data is unavailable, erasing SARPs, recorrelating all or part of a SARP, and various other system administration functions. One of the most critical parts of the MDDS program is the Maintain SARP/Departure Report and Total Cost function. From this function, mistakes in the SARP or departure report can be corrected. Additionally, the values entered in Total Cost function dictate the ultimate number of man-days in the MRS Representative Availability, and therefore determine the amount of ship maintenance funding in the future. The

following calculations are used to determine the man-days and material dollars for proration.

TYCOM ledger:

$$\text{Man-days} = \frac{(\text{Industrial\$} + \text{FIFO\$} + \text{Government Work\$}) \times (1 - \text{Mat'l Fraction})}{\text{Industrial Activity Man-day Rate}}$$

$$\text{Material} = (\text{Industrial\$} + \text{FIFO\$} + \text{Government Work\$}) \times (\text{Mat'l Fraction})$$

Where:

Industrial\$ = the total amount paid by the TYCOM to the primary industrial repair activity.

Industrial Activity Man-day Rate = The primary industrial repair activity labor, overhead, and profit (LOP) man-day rate or the average LOP rate for the SUPSHIP.

FIFO\$ = the total amount paid by the TYCOM directly to other repair activities.

Government Work\$ = the total amount paid by the TYCOM to Government Activities for anything except work package preparation.

Material Fraction = the portion of the shipyard costs spent on material (different for every SUPSHIP and Naval Shipyard)

Return Costs information:

Man-days =

$$\text{Return Man-days} = \frac{(\text{Subcontract\$} + \text{FIFO\$} + \text{GL\&MS}) \times (1 - \text{Mat'l Fraction})}{\text{Industrial Activity Man-day Rate}}$$

$$\text{Material} = \text{Return Mat'l} + (\text{Subcontract\$} + \text{FIFO\$} + \text{GL\&MS}) \times (\text{Mat'l Fraction})$$

Where:

Return Man-days = the total amount of labor man-days performed by the primary industrial repair activity

Return Material = the total amount of material costs incurred by the primary industrial repair activity

Subcontractor\$ = the total amount of subcontractor costs incurred by the primary industrial repair activity.

Industrial Activity Man-day Rate = The primary industrial repair activity labor, overhead, and profit (LOP) man-day rate or the average LOP rate for the SUPSHIP.

FIFO\$ = the total amount paid by the TYCOM directly to other repair activities.

GL&M\$ = the total amount of Government Labor and Material spent for anything except work package preparation.

Material Fraction = the portion of the shipyard costs spent on material (different for every SUPSHIP and Naval Shipyard)

Completion

The MRS data development will be completed annually by 1 July in order to provide the most current input to MRS and the US Navy's Planning, Programming, and Budgeting System.

APPENDIX D

GLOSSARY

Activity	Describes an organization. For example, a ship, a squadron, a naval station. An individual unit or command designated by a five or six figure numeric unit identification code (UIC).
Activity level	<p>Describes the degree of maintenance capacity and capability. There are three levels from least to most in terms of capacity and capability they are:</p> <p>O Organization-a ship or squadron I Intermediate-SIMA, or tender D Depot-Shipyard</p>
APIP	Availability Planning Improvement Process (APIP- a process used extensively in the submarine maintenance community). This process assigned risk to the deferral of work within the maintenance planning process. The original intent of APIP was to help overhaul planners manage risk in regard to mission readiness.
Appropriation	A product of the appropriations bill worked by the appropriations Sub-Committees through the Full Committee. A legally available authority to obligate the Treasury to make an eventual expenditure.
Authorisation	A product of the Authorization Bill worked through the Armed Services Committees. Provides no funding. Most obviously, provides for the authorization to procure weapons systems if funded and to pay entitlements which normally must be funded.
Availability	A period of time set aside to perform preventative and/or corrective maintenance.

CASREP Describes a naval message for an expeditious means of reporting a diminished combat readiness posture. Advises the operational chain of command of personnel, equipment, material condition which limit operational readiness: also alerts logistical commands.

Class Describes a ship type. For example, DD-963 SPRUANCE class destroyer, AE-21 SURIBACHI class ammunition ship.

Class Estimating Standards (CES) Created for submarine maintenance planning (both the 687 and 688 class), the Class Estimating Standards (CES) were designed to 1) help naval shipyards control cost 2) standardize the estimating base and 3) aid in budget development. CES does not perform a risk assessment nor does it show the impact of under funding the work package.

Class Maintenance Plan (CMP) Describes standard maintenance requirements for a class of ship. The class maintenance plan can be broken down into two parts 1) the Long Range Maintenance Schedule (LRMS-i.e., variable input) and 2) Time-Directed Requirements (i.e., fixed input).

Depot Describes a Public or Private shipyard.

EIC An alpha-numeric code used in the 3-M system to identify system, sub-system, and equipment in which maintenance is performed.

Fiscal year Begins 1 October and ends 30 September. For example 15 September 1992 is in fiscal year 92, 5 October 1992 is in fiscal year 93.

FLEET Atlantic or Pacific fleet commander-in-chief. Describes (a budget submission activity) a unified command.

FMPMIS Describes the Fleet Modernization Program Management Information System--Used to schedule and control the installation of alterations (e.g., ship alterations, machine alterations, etc.).

Funding Method of applying dollars to some activity.

FYDP Future Year Defense Program. The FYDP is a publication of the decisions that have been approved for DOD's program by the Secretary of Defense. The FYDP displays the manpower (military & civilian) and dollars involved in the approved programs for eight years. Force levels (such as aircraft inventories) are displayed for these eight years plus three additional years. FYDP is organized by major program and appropriation. It is updated five times during the biennial budget cycle. The FYDP for the 92-93 budget covers the following years:

<u>1990</u>	<u>91</u>	<u>92</u>	<u>93</u>	<u>94</u>	<u>95</u>	<u>96</u>	<u>97</u>	<u>98</u>	<u>99</u>	<u>2000</u>
PY	CY	BY	BY+1	+4 YEARS				+3 YEARS		
(FORCES ONLY)										

HP Hewlett Packard.

IBM-AT A micro-computer or personal computer (PC) manufactured by International Business Machines, Inc.

LAN Local area network.

Maintenance Action Describes a preventative or corrective repair job.

Maintenance Requirements Describes required preventative and corrective repair jobs that should be accomplished for the ship to perform all primary and secondary mission tasks.

Maintenance Requirements Systems (MRS) A decision information tool that defines maintenance requirements, projects those requirements over the POM, and indicates impact of less than full funding on mission capability.

Man-day (MD)	Describes input measure to direct labor. For example a job may require 300 man-days which is an estimate of the required direct labor to accomplish the job. Same as 2400 direct labor hours (DLH) (300 MD times 8 DLH per MD = 2400 DLH).
MB	Megabyte or 1 million bytes.
MHz	Megahertz or 1 million cycles per second.
Mission	Describes an organization's function or job. There are primary and secondary missions for various weapon platforms (i.e., a ship or plane - see appendix A for more information).
National Maritime Strategy (NMS)	NMS is the Secretary of the Navy's input to the Secretary of Defense's Defense Guidance. The current NMS is titled "From The Sea."
Naval Sea Systems Command	NAVSEA is part of the shore based infrastructure responsible for executing the overhaul and maintenance schedule, established by the CNO, at a naval shipyard or a private shipyard under the jurisdiction of The Superintendent of Shipbuilding (SUPSHIP).
OPNAV	Chief of Naval Operations staff, office codes are similar to Joint Chief staff (JCS) N1, N2, etc. vice OP 01, OP 02, etc.
Planning & Engineering For Repairs & Alterations (PERA)	Chartered to assist with overhaul and major availability work package development for designated ship types (i.e., PERA Surface, PERA CV, PERA Submarine)

POM

Program Objectives Memorandum-the Department of the Navy's (DON) POM is the Secretary of the Navy's (SECNAV) annual recommendation to the Secretary of Defense (SECDEF) for the detailed application of DON resources. Covers the objectives, planned activities and cost of each program. Contains information on the Navy programs planned for a six year period, prior & current year data, and documents changes to the Future Years Defense Plan (FYDP) proposed by DON. The first two years of the POM will later be changed into the budget that is submitted to the Congress. The POM highlights the first two years of the six years of new data it contains. For example, the information in POM 92-93 (sometimes referred to as POM 92) will be used as the basis for the 92-93 budget. Also shown in POM 92-93 are the prior and current budget years (90 and 91) and the next four years (94,95,96, and 97). POM 92-93 covers the following years:

<u>90</u>	<u>91</u>	<u>92</u>	<u>93</u>	<u>94</u>	<u>95</u>	<u>96</u>	<u>97</u>
PY	CY	BY	BY+1	NEXT 4 YEARS			

Program

Eleven programs currently identify broad areas of both mission and support

- 1-Strategic Forces
- 2-General Purpose Forces
- 3-Intelligence and Communications
- 4-Airlift/Sealift
- 5-Guard/Reserve Forces
- 6-Research and Development
- 7-Central Supply & Maintenance
- 8-Training, Medical and Other General Personnel Activities
- 9-Administrative and Associated Activities
- 10-Support of Other Nations
- 11-Special Operations Forces

**Program
budgeting**

Concerned with the output of programs. Sets forth what accomplishments can be expected from the resources made available.

**Program
Elements
(PE)**

A subdivision of a program. Identifies mission who performs mission. Is a basic building block of the Future Years Defense Plan (FYDP).

RAM	Random access memory.
RA/TA	Restricted Availability-is an availability assigned for the accomplishment of specific items of work by an industrial activity with the ship present. Technical Availability-is an availability for the accomplishment of specific items of work by a repair activity, normally with the ship not present, during which time the ship is fully capable of performing its assigned mission.
SARP	Ship Alterations and Repair Package. Displays the ship's total work package showing all work that has been identified, screened to the various repair activities and authorized for accomplishment or disapproved.
Scope	Describes the amount or size of a job.
Shipsheet	A listing of representative jobs and associated cost and risk data for a given availability.
SWAB	Stands for Ships work Authorization Boundary. This four digit number identifies specific systems to be worked on in a depot level environment.
SWLIN	Ship's Work Line Item Number, "SWLIN," is a term used to refer to a specific unit of work defined in the SARP. The SWILN is identified by the four digit SWAB Number, and a one digit number that identifies the reporting level breakdown within each SWAB.
TYCOM	Type Commander, for example SURFLANT & SURFPAC are the surface type commanders for the Atlantic and Pacific fleets respectively. Type commanders exist for the Aviation and Submarine communities as well (i.e., AIRLANT, SUBPAC, etc.).

WDC

Work Definition Conference. Held approximately six months in advance of the availability for the purpose of authorizing work to be performed.

3-M

Maintenance and Material Management System. System used throughout Navy for controlling repair, preventative maintenance support which assures maximum equipment operational readiness 3M Corp.

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